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SPECIFICATIONS
SPECIFICATION MEMORANDA
QUANTITIES AND ESTIMATING
LONDON BUILDING LAW
PROVINCIAL BUILDING LAW
EASEMENTS
BUILDING CONTRACTS
BUILDING SUPERINTENDENCE

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SPECIFICATIONS

SUBJECT MATTER OF A SPECIFICATION

GENERAL PRINCIPLES

1. Definition of a Specification.—The general meaning of the word **specification** is specific description, that is, a detailed and definite statement with regard to any particular subject. A specification with regard to a particular set of drawings, therefore, is a definite and formal mention of particulars explanatory (supplementary to the drawings and details) of the method of carrying out the drawings, both as to the labour and the materials that enter into the construction of a building. It also gives a careful definition of the relations between the various parties and the instruments necessary to the carrying out of the contract. These parties and instruments include the architect, owner, contractor, contract, specification, and drawings, and often the bills of quantities. The various relations between these parties and instruments are usually set forth in both the specification and the general conditions of contract.

2. Characteristic Features of Specifications.—The characteristic features of a specification should be: First, *brevity;* as few words as possible should be used in expressing what is desired, and repetition should be carefully avoided. Second, *clearness;* simple words, instead of unusual words, should be used. The technical terms in common use among tradesmen should be known and used in preference to non-technical words, where there is danger of ambiguity. General terms should be avoided

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whenever possible. Third, *order;* the headings should be arranged in approximately the same order in which the work referred to by them will be executed.

3. Qualifications of Writer.—The person who is to write the specification should carefully follow the drawings, which should be in pencil in a completed state. The drawings are often in pencil at this stage in order that small changes that suggest themselves may be made while writing the specification. Both the desires of the owner and the conditions of the site should be known, and the writer should be thoroughly versed in building construction. Constant vigilance must be exercised so that the latest improvements of science and art may be specified; and if it is desired to give the owner the advantages of all the improvements that are constantly being made, the merits of the various articles that the trade brings to notice should be investigated and decided on. The writer should therefore keep in touch with the arts and crafts through the various publications and catalogues of manufacturers, and should have as complete a file of these publications as possible.

4. A general outline consisting of the headings and their subheadings should be arranged and made as nearly perfect as possible. After this, the labour and material that is desired in each case should be given under each subheading. The drawings and other data for the work should constantly be kept in view and an effort made to form a mind picture of the entire building and the particular work that is being described, in order that details may be clearly expressed and the liability of omitting anything may be reduced to a minimum.

5. Contents of Specification.—A specification should always have: (*a*) a title, which shows to what work it belongs; (*b*) preliminary clauses, which contain all general items, a list of the drawings forming part of the contract, including the number of each sheet and a title showing with what work it deals, and any particulars that may be liable to affect the estimate; and (*c*) a full and complete description of all labour and material necessary for the erection of the building. This last

is usually distributed under the following, or similar, headings: (*a*) Excavator and concretor, (*b*) drainlayer, (*c*) bricklayer, (*d*) mason, (*e*) terra-cotta, faience, and tiling, (*f*) carpenter and joiner, (*g*) ironmonger, (*h*) slater and tiler, (*i*) zincwork and coppersmith, (*j*) heating and ventilating engineer, (*k*) founder and smith, (*l*) plumber, (*m*) gas-fitter, (*n*) electric wiring and bellwork, (*o*) plasterer, (*p*) glazier, (*q*) art-metal worker, (*r*) painter and decorator, (*s*) paperhanger.

Each item in a specification should be numbered, so that it may be readily referred to, and when necessary a sketch of the various details may be put in the margin, in order that there may be no doubt in the contractor's mind as to what is intended by the written description.

6. Each of the headings in the foregoing list contains subheadings, which comprise the various matters included under that particular heading. The list, which is arranged somewhat in the order in which the work will be executed, is only intended as a guide. In many cases, some of these items will be combined, while others may be omitted or replaced by some not mentioned. A large building will require many others, such as well sinker, marble mason, structural steel and ironworker, fireresisting constructor, etc.

7. In case the entire work is not under one contract, it should be stated at the beginning of each trade division, as, for example, carpenter work, mason work, etc., that "the general conditions at the beginning of the specification are hereby made a part of the contract for this division of the work except where they obviously do not apply"; or it may be stated that certain articles of the general conditions, designated by number, are to be considered as part of the specification. In describing a subject that entails a reference to an item in another trade, the number of the paragraph containing the item, enclosed in parentheses, should be given, so that it may be found readily if required.

8. Title.—The title of the specification should state the nature and the situation of the building and for whom the

(A)

SPECIFICATION

—— of ——

WORKS required to be done and materials to be used in erecting and completing a house at Sunbury in the county of Huntingdon for C. S. Roberts Esq.

Walter Smith,
Architect and Surveyor,
30, Gray's Inn Square,
London, W.C.

January, 191-

FIG. 1

S P E C I F I C A T I O N of WORKS required to be done and materials to be used in erecting and completing a house at Sunbury in the county of Huntingdon for C. S. Roberts Esq., according to drawings prepared by and instructions to be given by and under the Supervision and to the entire satisfaction of the architect

Walter Smith,
30, Gray's Inn Square,
London, W.C.

January, 191-.

PRELIMINARY CLAUSES

Drawings. The drawings forming part of the Contract and herein referred to are as follows:-

Sheet No. 1. Block Plan.
Sheet No. 2. Basement plan showing foundations.
Sheet No. 3. Ground-floor plan.
Sheet No. 4. First-floor plan.
Sheet No. 5. Attic-floor plan.
Sheet No. 6. Front Elevation.
Sheet No. 7. North East Elevation.
Sheet No. 8. South West Elevation.
Sheet No. 9. Section A.B.
Sheet No.10. Detail of Entrance.
Sheet No.11. Detail of recessed fireplace.
Sheet No.12. Detail of small bay to garden front.
Sheet No.13. Detail of window.
Sheet No.14. Joinery details.
Sheet No.15. Full size details.

FIG. 2

building is to be erected. If there is to be more than one specification, for example, if the plumbing, electric-wiring, and heating specifications are to be under separate covers, they should be numbered and this number placed in the title, as should also the particular number of the work, if it has any. The title should appear on the cover and first sheet, as should also the architect's name and office address.

In Fig. 1 is shown a facsimile reproduction of the cover of a specification as it should appear for the contract copy. The last page is signed by the builder and the employer, and very often the builder initials every page, so that he may know exactly what was included in the original specification. In Fig. 2 is shown the first page as it is generally set out. The drawings to be embodied in the contract and from which the house is to be built should be numbered consecutively from 1 onwards, and the specification should be marked A. The drawings and specification should then be signed by the employer and the builder, and left with the architect during the carrying out of the works, the builder being supplied with copies only for his own use. Specifications are usually typewritten, but sometimes are reproduced by lithography to obtain the number of copies required.

9. Headings and Subheadings.—The general headings should be placed in the centre of the page, and each heading should start a new page. The subheadings should be placed in the left margin of the sheet immediately over or alongside the paragraph to which they refer.

10. Index.—On the sheets following the title of the specification there is sometimes inserted an index of headings and subheadings. Each item of the index should be numbered to correspond with its number at the beginning of each paragraph on the margin of the specification. Obviously, the making of the index should be left until after the specification is typewritten. While this style of index requires more time and labour than an index of pages only, it is very thorough, and will greatly assist anyone not familiar with the document in finding the specification of any particular item. As a further convenience it might be arranged alphabetically.

EXAMPLE OF A SPECIFICATION

INTRODUCTION

11. The following is a sample specification for the residence shown in Figs. 3 and 4, the working drawings for which are given in *Architectural Drawing*, which should be completed before this Section is commenced. In the specification clause dealing with drawings, Art. **13**, is given a list of those on which the contract is based; these drawings in ordinary practice would be numbered from 1 to 15 consecutively, as shown. They will all be found in *Architectural Drawing* by their titles; some are drawing plates, and others are illustrations in the text. If a drawing is referred to in the specification as Sheet No. 11, a reference to Art. **13** will show that this is a detail of the recessed fireplace. If the drawing entitled Detail of Recessed Fireplace is now found in *Architectural Drawing*, the specification clause in which the reference occurs can be better understood. Each type of building requires a different specification, but the general method is the same for all, and with the principles in mind and a thorough knowledge of building construction, no trouble should be encountered in adapting them to the different conditions. The different fittings, materials, etc., specified are simply given as examples, and it is not intended to suggest that they are preferable to the many other excellent articles on the market.

The words *prime cost*, usually abbreviated p.c., when used in a specification refer to sums to be paid by the contractor to the merchant after deducting all trade discount, but not deducting discount for cash. The articles of this specification are numbered in continuation of the articles of this Section; this has been done to facilitate reference. In an actual specification, these numbers would, of course, begin at 1. The sketches are also numbered consecutively for ease in reference, though in practice they are placed in the margin and not numbered.

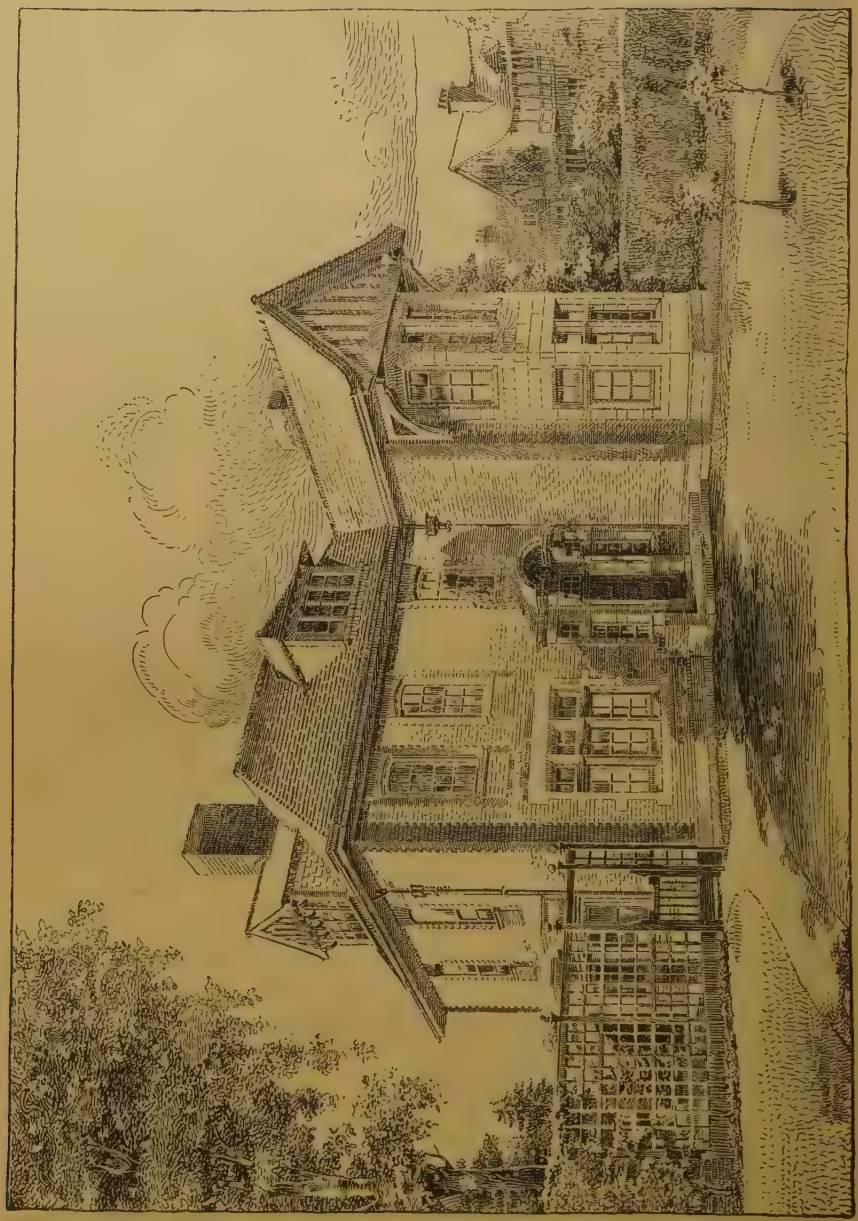

FIG. 3

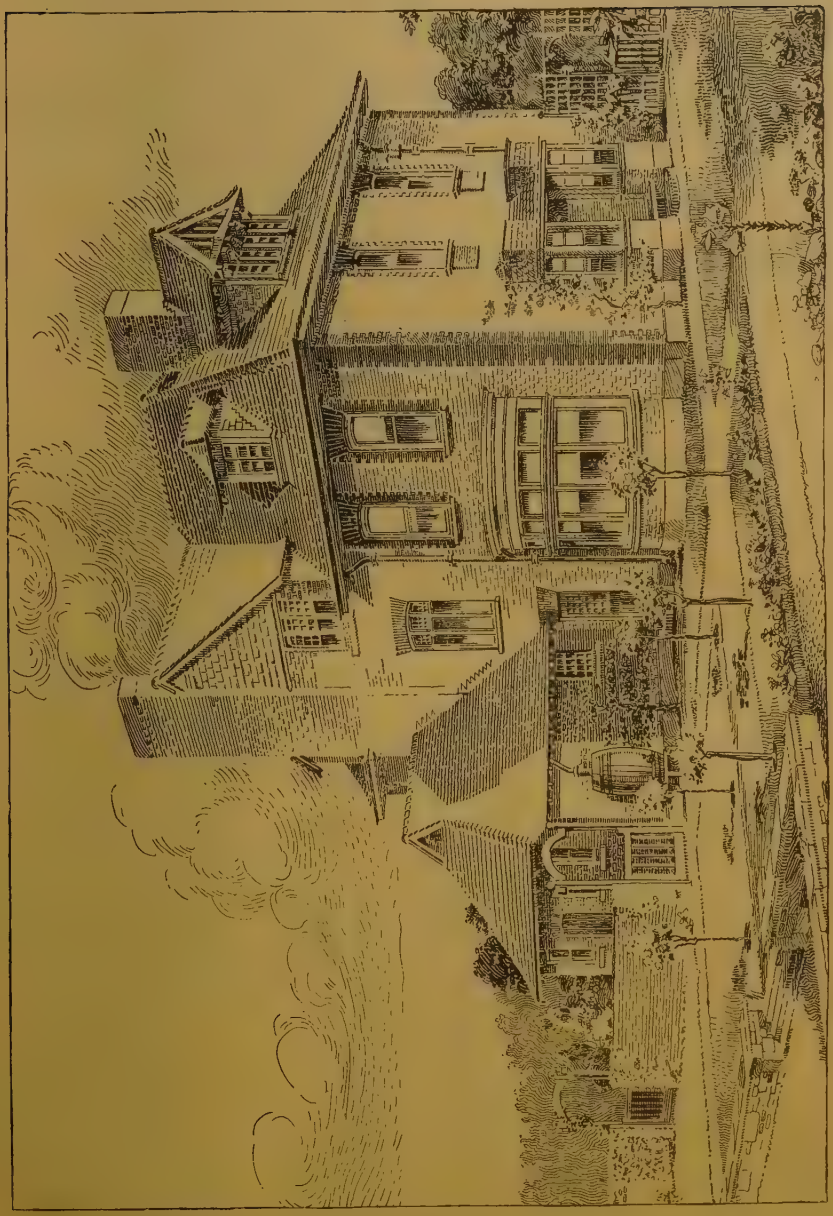

Fig. 4

TITLE

12. Specification of works required to be done and materials to be used in erecting and completing a house at Sunbury, in the county of Huntingdon, for C. S. Roberts, Esq., according to drawings prepared by and instructions to be given by and under the supervision and to the entire satisfaction of the architect.

WALTER SMITH,
30 Gray's Inn Square,
January, 191– London, W.C.

PRELIMINARY CLAUSES

13. Drawings.—The drawings forming part of the contract and herein referred to are as follows :

Sheet No. 1. Block plan.
Sheet No. 2. Basement plan showing foundations.
Sheet No. 3. Ground-floor plan.
Sheet No. 4. First-floor plan.
Sheet No. 5. Attic-floor plan.
Sheet No. 6. Front elevation.
Sheet No. 7. North-East elevation.
Sheet No. 8. South-West elevation.
Sheet No. 9. Section A-B.
Sheet No. 10. Detail of entrance.
Sheet No. 11. Detail of recessed fireplace.
Sheet No. 12. Detail of small bay to garden front.
Sheet No. 13. Detail of window.
Sheet No. 14. Joinery details.
Sheet No. 15. Full size details.

14. Conditions.—The general conditions are those printed and issued by the Royal Institute of British Architects, and will form part of the contract. The form of contract to be used will be that issued by the Royal Institute of British Architects, and the contractor, by his act in submitting a tender for the carrying out of work under this specification, signifies his assent to the use of this form of contract in its entirety.

15. Materials and Labour.—The contractor shall provide all material and labour of every description necessary, and all plant, gear, scaffolding, tools, implements, haulage, and other requisites whatsoever necessary for the proper and effectual carrying on, execution, and completion of the whole of the works described in this specification. He shall finish the works according to the true intent and meaning of the drawings

and specification taken together, whether the same may or may not be particularly shown on the drawings or described in the specification, provided that the same is reasonably to be inferred therefrom.

16. Setting Out.—The contractor shall set out the whole of the works and be responsible for same. He shall amend any errors that may arise from an inaccurate setting out free of cost to the employer, unless the architect shall decide to the contrary. All figured dimensions on the drawings are to be followed in preference to scaled dimensions.

17. Water.—All temporary plumbing work, pipes, tanks, fittings, etc., and water that may be required shall be provided by the contractor, who shall also give the necessary notice to the water company and pay all fees legally demandable in connection with the supply of water for the use of the works.

18. Temporary Protection.—All walls, trenches during excavation, and such other parts of the building as may be necessary shall, during inclement weather, be protected by means of tarpaulins or in other way so as to keep the buildings, as far as possible, immune from damage.

19. Damage.—All pointing or other work damaged by frost, settlements, etc., must be re-executed to the architect's satisfaction.

20. Damage to Adjoining Property.—The contractor shall be responsible for all structural and decorative damage to property and for injury caused by the works or workmen to persons, animals, or things, and shall hold the employer harmless in respect thereof. He shall also be entirely responsible for any or all claims that may be made under any Workmen's Compensation Act, or other Act of Parliament that may now be in force or that may come into force during the period of the continuation of this contract, and shall hold the employer entirely free from all responsibility in respect thereof. He shall also be responsible for all injuries caused to the buildings the subject of this contract, and shall reinstate all damage caused by the same.

21. Foreman.—A competent general foreman shall be kept constantly on the work, and any directions or explanations given by the architect to such foreman shall be held to have been given to the contractor.

22. Clerk of Works.—The contractor shall provide a proper office for the clerk of works, with all necessary lighting, firing, water, and attendance required, and provided with desk, drawing table, and lavatory basin.

23. Sheds and Latrines.—Sheds, and latrines properly connected to the drains and supplied with water, shall be provided for the use of the workmen. They shall be kept clean and disinfected during the progress of the work and entirely removed on completion, the drains and all work connected therewith being grubbed up. The contractor shall similarly provide and erect all sheds necessary for the storage of materials, tools, etc.

24. Hoardings.—All hoardings necessary or required, with gates, locks, fastenings, etc., shall be erected by the contractor. They shall be as complete as necessary or required by the local surveyor. The contractor shall also give all notices that may be required, pay all fees, remove all hoardings when no longer required, and make good damage that may have been done.

25. Insurance.—The contractor shall insure the works, and keep them insured until they are delivered up, against loss or damage by fire, in an office to be approved by the architect. The policies shall be in the joint names of the employer and the contractor. They shall be for the full value of the works executed and, with the receipts for the premiums paid, shall be deposited with the architect. In default, the employer may insure the works and deduct the premium paid from any moneys due or which may become due to the contractor. All moneys received under such policies are to be paid to the contractor by instalments on the certificate of the architect, and are to be applied in or toward the rebuilding or reparation of the works destroyed or injured. The contractor shall, as soon as the claim under the policy is settled, proceed with all diligence with the rebuilding or reparation, and shall not be entitled to any payment in respect thereof other than the said money received, but such extension of the time for completion of the works shall be made as shall be just and reasonable.

26. Notices.—The contractor shall conform to the provisions of any Acts of Parliament relating to the works and to the regulations and by-laws of any local authority and of any water and lighting companies with whose systems the structure is proposed to be connected, and, before making any variation from the specification that may be necessitated by so conforming, shall give to the architect written notice specifying the variation proposed to be made. The contractor shall give all notices required by the said Acts, regulations, or by-laws, and shall pay all fees payable to any such authority or to any public officer in respect of the works and shall supply any drawings required by them.

27. Diversion of Mains.—The contractor shall alter and divert all gas, drain, water, electric-light tubes, mains, etc., or other pipes and mains discovered under a public footway or on the site, giving all necessary notices in respect of same and making good all work disturbed.

28. Rubbish.—All rubbish as it accumulates and all superfluous materials shall be cleared out and removed from the site or premises, which shall be left clear at the completion of the work.

29. Lighting and Watching.—Any artificial lighting required to complete the works at the time stated shall be provided by the contractor, who shall also provide a watchman, if necessary or desired, and a temporary office or box for him with firing and attendance.

30. Night Work.—Any night work necessary in order to complete the works by the time named shall be provided by the contractor.

31. Time of Completion.—The works shall be commenced within 3 days after the architect's order to commence and shall be completely finished and delivered up within 8 calendar months from the date of commencement. Should the works not be completed entirely to the architect's satisfaction by that time, the contractor shall pay to the employer the sum of £10 per week as ascertained and liquidated damages, and not as a penalty, for every week or part of a week during which the works shall remain incomplete.

32. Payment.—Payment will be made at the rate of 80 per cent. of the work executed until the retention money amounts to the sum of £200, after which payment shall be made up to the full value of the work executed. The contractor will receive the payment of £100, being part of the said sum of £200, when the works are completed, and the full balance within a period of 6 months from the date of completion, subject nevertheless to the provisions of the following clause.

33. Defects.—The contractor shall make good, entirely to the architect's satisfaction, all defects arising, in the opinion of the architect, from work or materials not in accordance with the drawings or the specification or the instructions of the architect that may appear within 6 months from the completion of the building. Should the defects not be made good within such time as the architect shall determine and entirely to his satisfaction, the architect may call on such other persons as he may think fit to amend and make good such defects, shrinkage, or other faults or damage, and may deduct the cost of same from any money due from the employer to the contractor.

34. Copy of Prices.—Before the contract is signed, the contractor shall deposit with the architect an unsealed copy of the bills of quantities fully priced and moneyed out, cast, and carried to the summary so as to agree with the amount of his tender ; this shall form a schedule by which all extra and omitted works will be valued.

35. Provisional and P.C. Sums.—All provisional sums which are quoted in this specification as p.c. are to be taken as absolutely net, and the contractor must add any profit, etc., he requires to all such items. All provisions and provisional amounts are to be used as directed by the architect and deducted wholly or in part if not required, and the contractor must arrange with the various subcontractors accordingly. The architect reserves to himself the right to obtain further estimates for all provisional sums, and obtain any saving on the contract by this means, and to appoint any subcontractor to do the work.

36. Facilities to Subcontractors.—All necessary facilities, together with use of plant, staging, scaffolding in position, water, etc., shall be provided by the contractor for all special tradesmen who may be appointed by the architect to carry out any work, whether or not same shall be specially provided for by this specification. He shall cut away for and make good after them. The contractor shall ascertain from each tradesman appointed what chases, etc., are requisite for his individual work and shall arrange for and build them as the work proceeds. He shall be entirely responsible for any damage to goods provided by the employer or any special tradesman or subcontractor after they have been delivered to the site.

37. Attendance.—The contractor shall attend on, cut away for, and make good after all trades and in all trades.

38. Cleaning Up at Completion.—The contractor shall clean up the whole of the site and buildings at the completion of the contract, and shall leave the whole perfectly clean and complete in every respect. All floors shall be cleaned down and well scoured and scrubbed and all glass cleaned inside and out and renewed wherever cracked or broken. On completion, the whole premises must be left clean and perfect and fit for immediate occupation.

39. Contingencies.—The contractor shall provide the sum of £100 for contingencies. This sum is to be expended only as the architect may direct, and will be deducted, if not required, in whole or in part, from the amount due to the contractor on the completion of the work.

EXCAVATOR AND CONCRETOR

40. Cesspools on Site.—Any cesspools, wells, etc., found on the site must be emptied or cleaned and the existing top soil removed. The place must then be filled with earth, or hard broken-brick rubbish, which must be rammed.

41. Curios.—All curiosities, relics, coins, etc., found in excavating or pulling down shall be the property of the employer and must be handed to the architect. Should any ancient masonry, pavements, or other work of interest be opened up, the architect's attention shall be called to the same before it is demolished or removed.

42. Vegetable Soil.—All vegetable soil from the whole area to be occupied by the building or any yard and steps must be removed to a depth of 12 inches below the surface.

43. Trenches.—The trenches for the walls, and the space occupied by the basement, shall be excavated to the full widths and depths shown

and figured on the drawings. The bottom of all excavations shall be well rammed to receive concrete. All trenches must be left open for inspection and approval by the architect before concreting is commenced.

44. Maintenance of Excavations.—The sides of all trenches and other excavations must be thoroughly strutted, or otherwise secured, and all pumping necessary to keep the excavations free from standing water must be performed.

45. Sand and Ballast.—Any sand and ballast found on the site may be used for the purposes of these works if their quality is approved by the architect, but none may be carted away.

46. Cement.—All cement shall be Portland, obtained from an approved manufacturer. It must be of such quality as to be in conformity with the British Engineering Standards Committee's specification. If the architect should entertain any doubt as to its quality, it shall be tested as he may direct; the expense of testing shall be borne by the contractor if the cement should prove faulty, but not otherwise.

47. Concrete.—The concrete for foundations and under drains shall be composed of 1 part of cement, 2 parts of clean sharp sand, free from loamy or organic matter, and 4 parts of broken brick, ballast, or other aggregate approved by the architect. All material is to be measured by bulk and thoroughly mixed when dry, on a boarded floor, and water afterwards added.

48. Laying Concrete.—Concrete foundations under walls shall be of the full widths and depths shown. They must be thoroughly consolidated and worked to an even and truly level surface with a spade. All surface concrete is to be laid in a similar manner fully 6 inches thick and left with face ready to receive granolithic or other paving specified. No walls or pavings are to be laid on the concrete until same is thoroughly set.

49. Concrete Floors.—The concrete under all wood-block, tile, or other solid floors is to be similar to that just described, but it must be laid on a 6-inch bed of broken brick, or other hard dry material, which has been well rammed.

50. Hearths.—The concrete for the hearths shall be similar to the foregoing, but cast in slabs 6 inches thick. These slabs are to be supported on wooden fillets that are nailed to the joists and trimmers, and are to be 12 inches wider than the fireplace opening in each case, except that to kitchen fireplace, which is to be 18 inches wider than the opening. The hearths throughout are to be 18 inches wide from the face of the jamb to the front of the hearth for all rooms except the kitchen, which is to have a hearth 24 inches wide from the face of the jamb. These dimensions are to be worked to accurately unless the architect shall direct to the contrary.

51. Lintels.—The contractor shall provide and fix over front-entrance door opening two 4″ × 3″ rolled-steel joists, embedded in concrete giving a cover of at least 2 inches thick all round. He shall also provide and fix over each window in the kitchen and pantry, and over the door and window of the furnace room, concrete lintels 9 inches deep and having a $4\frac{1}{2}$-inch bearing in the brickwork at each end.

52. Coke-Breeze Fixing Bricks.—The contractor shall provide and fix, where required for fixing joinery to, 9″ × $4\frac{1}{2}$″ × 3″ coke-breeze fixing bricks, and shall build same into walls as work proceeds.

53. Holes for Pipes.—All holes in concrete or tile and other floors for pipes, chases, etc., shall be formed by the contractor as required; he shall make good all damage done.

DRAINLAYER

54. Stoneware Pipes.—Only the best salt-glazed stoneware socketed pipes shall be used. These must be well burnt and glazed throughout, circular in section, smooth, straight, true in bore, and free from cracks and flaws, and to the approval of the architect.

55. Excavate for Drains.—The contractor shall excavate the ground for the trenches for pipes, ram the bottom to form a solid foundation and even bearing, and lay the pipes on concrete, as described, to an even fall. Afterwards he shall fill in and ram the earth round the pipes and cart away all surplus dirt. He shall provide any necessary planking and strutting and shall clear it away on completion.

56. Gullies and Traps.—All of the gullies, traps, manhole channels, and other drainage connections shall be of similar quality to the salt-glazed stoneware pipes.

57. Laying Drains.—All drains shall be commenced at the point of outfall and worked back to the highest part, all branches and other connections being put in as the work proceeds. The whole of the drains shall be accurately laid to a fall of 1 in 40 and butted close together at the joints. All drains must be laid to a true and even gradient on a 6-inch bed of cement concrete and flanged round after laying, as shown in the sketch (Fig. 5). All joints and connections must be carefully made, solidly bedded, and jointed in neat Portland cement, and finished with a bold collar of the same.

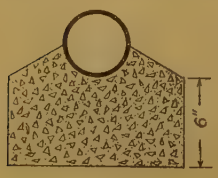

Fig. 5

58. Bends.—All bends, junctions, tapers, etc., shall be provided with sweeping eyes where required, and shall be connected to chambers and

gullies as required. No square junctions are to be used, and all bends must be of easy curve.

59. Manhole Channels.—Main channels passing through manholes shall be half round, bedded and jointed in neat Portland cement on a 6-inch bed of concrete. The branch channels shall be of three-quarter section, of similar manufacture, and laid to discharge over the edge of the main channel.

60. Gullies.—All gullies shall be trapped salt-glazed stoneware, having a 6-inch rabbeted top with a galvanized-iron grid and a 4-inch outlet.

61. Manholes.—Manholes must be built where shown on the drawings and of the sizes figured. They must be of 9-inch stock brickwork laid in cement, and have two courses of footings on a 6-inch bed of cement concrete that projects at least 4 inches all round beyond the lowest course of footings. All channels shall be properly bedded and jointed on solid concrete in neat cement to an even gradient, with benchings formed to same and finished with a $\frac{3}{4}$-inch floating of neat cement. The inside faces of manhole walls are to be rendered in cement. The cover must be a heavy galvanized-iron double-seal, laid in Russian tallow on a frame which is to be bedded in cement on proper oversailing courses.

62. Disconnecting Trap.—The contractor shall provide and fix at outgo of drain from the last manhole a 4-inch salt-glazed stoneware disconnecting trap with a cleaning arm securely covered by means of a disc of slate bedded in cement.

63. Grease Trap.—The contractor shall provide and fix to sink waste an earthenware grease trap of approved pattern and a gully with cast-iron cover, which shall be bedded in cement and jointed to the drain.

64. Fresh-Air Inlet.—The contractor shall provide and fix a 4-inch salt-glazed outgo pipe from the last manhole to act as a fresh-air inlet. This pipe must be carried up 2 feet above the ground, level against fence, and finished with a galvanized-iron mica-flap inlet box with a brass grid.

65. Sumps.—The three surface-water gullies that are not connected to the drainage must be connected by pipes to sump pits, 2 feet by 2 feet by 2 feet, filled with dry brick rubbish or other suitable porous material. The sump, to take water from the area outside furnace room, must be placed as far from the building as possible and adjoining the fence.

66. Connection to Sewer.—The contractor shall give notice, take up the pavement and roadway, open up the ground or tunnel under as necessary, and provide an eye for, and connect the drain to, the sewer, or pay fees for same being done by the local authorities. He shall lay a 6-inch drain from the disconnection chamber to the sewer with all necessary

digging, filling in, and ramming. He shall also relay roadway and pavement and cart away all surplus earth, shall provide all planking and strutting required, and shall pay all fees in connection with same. All work must be done to the satisfaction of the architect and local sanitary authority.

67. Testing Drains.—None of the drainage work shall be covered up until it has been subjected to the water test and passed as satisfactory by the architect and the surveyor to the local sanitary authority.

BRICKLAYER

68. Bricks. — All bricks must be good, sound, hard, square, well burnt, equal in all respects to a sample deposited with and approved by the architect.

69. Facing Bricks.—The facing bricks must be hand-made sand-faced bricks from an approved brickfield ; the colour is to be selected by the architect. Crowborough purple stock bricks are to be used for the ordinary facings and bright red bricks for the quoins and window dressings.

70. Stocks.—Bricks for foundations and internal walling, or where covered by tile hanging, are to be of the best-quality stock bricks.

71. Rubbers.—The rubbers are to be of even quality, free from lumps, and of a colour approved by the architect.

72. Glazed Bricks.—The glazed bricks used round the dining-room fireplace must be from the Leeds Fireclay Company or other approved manufacturer, and of a colour and glaze selected by the architect. They are to be small bricks, laid five courses to the foot with the joints pointed in Keene's cement.

73. Sand.—All sand used for mortar must be clean, sharp, pit sand, free from all loamy and organic matter, and must be washed and screened if so ordered by the architect. Sea sand must not be used.

74. Lime.—All lime must be freshly burnt blue lias, or other approved hydraulic lime. It must be thoroughly slaked on the site with a sufficient quantity of water and covered with sand to keep in the heat and moisture.

75. Water.—All water used must be fresh and clean.

76. Lime Mortar.—Lime mortar will be composed of 1 part of lime to 3 of sand and only mixed up in sufficient quantity to serve 1 day's requirements. The lime and sand must first be thoroughly mixed dry and water afterwards added.

77. Cement Mortar.—Cement mortar will be composed of 1 part of Portland cement to 2 parts of sand thoroughly mixed dry and water afterwards added. No cement that has been mixed for more than 1 hour, or that has taken an initial set, shall be used.

78. Dimensions.—All brickwork must be carefully and accurately set out to the exact dimensions shown and figured on the drawings.

79. Laying Bricks.—All bricks must be well wetted before being laid, and the vertical joints are to be well flushed up as the work proceeds. No four courses are to exceed by more than 1 inch the height of four courses laid dry. All the brickwork must be carried up as uniformly as possible and no part is to be carried up more than 4 feet above any other part, unless for some special reason and with the consent of the architect.

80. Frost.—No bricklaying is to proceed during frosty weather, unless with the consent of the architect, whose directing as to the means to be employed to prevent detriment to the brickwork shall be absolutely adhered to. Newly laid brickwork must be covered at night during frosty weather.

81. Bond.—All facing work is to be laid in Flemish bond and all other work in English bond.

82. Footings and Walls Under Ground Floor.—The footings shall be built to spread on each side of the walls; the walls, fireplace piers, etc., above the footings to the level of the ground-floor wall plate shall be built to the required thickness, and all must be built as shown on the drawings. The interior face of walls under the ground-floor level shall be built fair-faced and finished with neat struck joints.

83. Filling In.—The contractor shall return and well ram round all foundations, brick footings, and basement walls with good, hard, dry material reserved from the excavations.

84. Damp-Proof Course.—The contractor shall provide and lay over the surfaces of all walls above ground level a proper damp-proof course of $\frac{3}{4}$-inch asphalt or two courses of slates laid lapping joint and bedded in cement. The outside face of all external walls below stone plinth and down to concrete foundation shall be rendered with neat cement $\frac{3}{4}$ inch thick.

85. Plumbing and Relieving Arches.—The reveals of door, window, and other openings shall be properly plumbed; and, where practicable, two $\frac{1}{2}$-brick ring segmental arches shall be turned over all openings as relieving arches.

86. Air Bricks.—The contractor shall provide and build in, where required, 30 terra-cotta air bricks for ventilation to floors, and shall form flues through wall for same, the openings to be rendered in cement.

87. Fireplace Openings.—The fireplace openings shall be built to the sizes shown on the drawings, and a wrought-iron bar with ends split and turned up and down, provided by the smith, shall be built in over each opening. A rough segmental arch of two $\frac{1}{2}$-brick rings shall be built over same. The openings shall be properly contracted and gathered over to form mouths to flues to prevent down draught. All chimney backs and brickwork of flues near woodwork shall be rough rendered in cement.

88. Kitchen Fireplace.—The kitchen fireplace, jambs, and head shall be built of brick and afterwards rendered with $\frac{3}{4}$-inch cement. Over the opening, an arch of two $\frac{1}{2}$-brick rings in cement shall be built on a $2\frac{1}{2}'' \times \frac{1}{2}''$ wrought-iron bar turned up and down at ends and fixed on the outside of jamb where it is 9 inches thick and inside jamb on other side.

89. Flues.—The smoke flues shall be carefully bonded and built of the full bore shown ; all flues shall be parged and carefully cored as the work proceeds. Openings shall be left in the face of the chimney breasts where required for coring, but they shall afterwards be built up. Each flue is to have easy graduated bends ; no flue shall be allowed to be perfectly straight from the fireplace to the chimney head. The chimney stacks are to be built in cement mortar above the roof line, but pointed in lime mortar to match other work. Provide and fix to each flue a chimney pot to be approved by the architect and bed and flaunch up to same in cement.

90. Bed Plates and Chases.—The contractor shall form all necessary chases for pipes and other work and all necessary oversailing courses to support plates and other timbers. He shall properly bed all plates in cement and perform all necessary rough and fair cutting.

91. Building In Stoves.—The contractor shall accept delivery of the kitchen range, scullery copper, and all the room stoves or grates and iron mantels from the founder and properly build in and set same. The kitchen range and scullery copper shall be set in brickwork, with firebrick linings in fireclay to all flues ; the top and sides of the scullery copper shall be finished with Portland cement $\frac{3}{4}$ inch thick, finished off the float. The contractor shall also provide and build in all dampers, soot doors, etc.

92. Sink.—The contractor shall provide and fix a $2'\ 6'' \times 1'\ 6''$ cane and white-glazed deep earthenware sink on $4\frac{1}{2}$-inch white glazed-brick piers with bullnosed angles.

93. Beam Filling.—The space above the wall plate for rafters shall be built up 9 inches thick to the under side of the roof boarding as beam filling.

94. Breeze Fixing Bricks.—Coke-breeze fixing bricks shall be built into door and window openings and elsewhere as required for fixing joiner's or other work.

95. Brick Floors and Brick Steps.—The floor of the furnace room shall be laid with best Staffordshire blue bricks set on edge in Portland cement. The steps and paving to the seat between the small bays and entrance to scullery and also the paving to the front entrance shall be hard-burnt non-absorbent red bricks of an approved make, set on edge in cement. All must be as shown on the drawings; for dwarf and parapet-wall copings of front-entrance door see Sheet No. 10. The contractor shall include for cutting purpose-made and bullnosed bricks, and the necessary foundations under the brick and stone steps and paving. All the brick paving shall have a 6-inch layer of concrete on broken brick laid underneath.

96. Building In Sills and Steps.—All steps, thresholds, ends of joists, window frames, etc., shall be built in, bedded, and set in cement, and pointed as required.

97. Pin to Stonework.—The brickwork shall be well pinned and backed up to the stonework and cut and fitted to the ends of steel beams.

98. Furnace-Room Door and Window.—The door and window jambs and reveals of the furnace room shall be built square; the window sill shall be formed of bullnosed bricks on edge, set in cement.

99. Door and Window of Scullery Wing.—The two outer doors from scullery and staircase, and all the windows of the scullery wing, shall be built with $\frac{1}{2}$-brick reveals on the outside.

100. Brick Reveals and Rabbets of Other Windows.—All other windows, except dormers and where faced with stone, shall have the wooden frames fixed on the outside of the brick rabbet, as shown on the drawings.

101. Brick Apron Below Sills of Windows.—The brick apron below the sills of the windows, where shown on the drawings, shall project 1 inch from the face of the wall to a depth of 1 foot 3 inches below the sill, and shall be faced with red bricks similar to the quoins.

102. Window and Door Arches.—The segmental window and door arches shall be carefully set out and built of rubber and gauged brick set in putty, as shown on the detail drawings. The contractor shall include for neatly cutting the facing bricks at springing of arches as required.

103. Morning- and Drawing-Room Bays. — The brick corners of the base of the two small bays of the morning- and drawing-room and the segmental base of the large bay of the latter shall be purpose made. The sill course shall be in bricks set on edge, as shown on Sheet No. 12.

104. Pointing External Walls. — The whole of the exterior face work shall be pointed with a neat weather joint in white mortar, cut in top and bottom; the pointing shall be done as the work proceeds.

105. Internal Walls.—All internal and gable walls, where covered with hanging tiles, except where otherwise specified, shall be left rough for plastering. The interior walls of the servants' w.c., coal cellar, and basement shall be finished fair with neat struck joints.

106. Fixing Blocks for Hanging Tiles.—The gable of the back elevation, where it is covered with hanging tiles, shall be provided with a sufficient number of breeze fixing bricks to which the tiling battens shall be fixed.

107. Raking Out at Flashings.—All joints for flashings shall be carefully raked out and afterwards pointed in cement.

108. Attendance.—The contractor shall attend on, cut away for, and make good after all other trades throughout, and leave clean, perfect, tidy, and entirely to the architect's satisfaction at completion.

MASON

109. Stonework.—The whole of the stone shall be of the best of its respective kind and shall be worked to lie on its natural bed.

110. External Dressings.—The stone for all external work, except where otherwise specified, shall be Portland stone, finely chiselled on all the exposed surfaces, set in lime mortar, and finished with neatly struck joint.

111. Covers.—The covers on top of steel joists, and for manholes, etc., shall be of hard York stone, neatly tooled. The whole of the stonework shall be carefully cleaned down at completion.

112. Moulded Work.—All moulded or splayed work shall be carefully worked to the full-size details to be supplied.

113. Base Course.—The base course shall be laid in two courses splayed on the top of the upper course, except round the small bay windows, where there will be no splay. Round the small bays, the base course shall be 9 inches on the bed and shall average 7 inches elsewhere. The contractor shall include for returning splays at doors and for butting against the small bay windows.

114. Main-Entrance Door.—All the stonework of the main-entrance door shall be worked, moulded, and built as shown on Sheet No. 10. The two corbels shall be left boasted for the carver. The p.c. sum of £5 shall be included for carving the two corbels, and the necessary models are to be supplied.

115. Dining-Room and Bedroom Bay. — The dining-room and bedroom bay up to the level of the gable tie-beam shall be built of stone. The wall and corner piers, mullions, and lintels shall have splays and double rabbets wrought on the edges to the girth of $6\frac{1}{2}$ inches; they shall also be rabbeted for casement frames. The transom shall be splayed, etc., on the under side in the same manner as the mullions and weathered on top A groove for the metal water bar must be worked in the sills and transoms. The portion between the lintel of the dining-room window and the sill of the bedroom window shall be faced with ashlar, having an average bed of 7 inches, as shown on the detail drawing.

116. Morning-Room Three-Light Window. — The sill, jambs, mullions, transoms, and lintels of the morning-room three-light window shall be of stone. They must be splayed, etc., as described for the dining-room bay and as shown on Sheet No. 13.

117. Stone Window Sills.—The stone window sills shall be grooved for metal water bar, weathered on top, throated, and moulded on the under side, as hereafter specified, with returned ends as shown on the drawings.

118. Drawing-Room Bay-Window Sill.—The sill of the drawing-room window shall be segmental on plan, 9 inches wide by 6 inches deep; it shall be weathered on top and throated on under side.

119. Bedroom Window Sills.—The sills of the windows in the bedrooms and dressing-room over hall, morning- and drawing-rooms shall be weathered, throated, and moulded as shown on detail drawing. They shall be 8 inches wide by 6 inches deep. The two bedroom windows over drawing-room bay shall be 1 inch less in width, and there shall be no brick apron under the sill. The other bedroom, kitchen apartments, bathroom, w.c., and staircase window sills shall be as specified for drawing-room, only straight instead of segmental on plan.

120. Dining-Room Ingle-Window Sills and Lintel.—All sills and the band course of the dining-room recessed fireplace shall be 9 inches deep and of a depth of bed shown and figured on the detail drawing. The sills shall be splayed on top and grooved for the water bar. The lintel and band course shall be 12 inches deep by 9 inches wide, and the lintels shall be splayed and rabbeted. All work shall be as shown on Sheet No. 11. The set-offs on dining-room fireplace and chimney stack shall be as shown on Sheet No. 11 and according to the sizes marked.

121. Chimney and Other Copings.—All copings of chimneys shall be 12 inches deep by the full thickness of the chimney stacks, and where possible shall be in one stone. The top arris shall be rounded and the copings shall be perforated for the smoke flues. Copings shall be set and jointed in cement mortar. The coping of outside steps to furnace room shall be 9 inches by 6 inches, slightly rounded on arrises, laid in long stones, and set in cement; the contractor shall include for cutting holes at 3-foot centres for iron railing. The terminal block of parapet at front entrance shall be 9 inches thick by 12 inches by $13\frac{1}{2}$ inches, as shown on Sheet No. 10.

122. Stone Seat Between Bays.—The York-stone seat between the two small bays shall be 18 inches wide by 3 inches thick and slightly rounded on the upper front edge. The seat shall be built into the brick wall, as shown on Sheet No. 12.

123. Stone Steps to Front Entrance.—The steps to front entrance shall be 15″ × 6″ hard York stone.

124. Inside Steps to Furnace Room.—The inside stone steps leading to furnace room shall be 15″ × 3″ York stone, as shown on the section.

125. Outside Steps to Furnace Room.—The contractor shall provide and build in 10″ × 9″ blue Pennant stone steps leading to furnace room.

126. Wine-Bin Stone Shelves.—The stone shelves of wine bins shall be 3-inch York stone; the contractor shall include for building brick divisions as shown on drawings.

127. Templates.—The contractor shall provide under ends of all rolled-steel joists hard York templates across the full thickness of wall, 3 inches thick and 6 inches longer than bearing of joists. He shall also provide similar cover-stones over all joists where not embedded in concrete.

CARPENTER AND JOINER

128. Fir Timber.—Only best red fir from Memel, Danzig, or Riga, or timber of equal quality approved by the architect, shall be used for the carpenter's and joiner's work. It must be thoroughly well seasoned, free from sap, shakes, waney edges, large, loose, dead, or unsound knots, decay of any kind, and all other defects.

129. Oak.—All oak must be British or European grown, well seasoned, and free from sap.

130. Cut and Stack.—As soon as the contract is signed, all the timber for both carpenter's and joiner's work shall be cut out and stacked, but it shall not be wedged up until just before fixing.

131. Exposed Faces.—All exposed timber must be wrought on all exposed surfaces, unless otherwise specified, and wherever else necessary for the proper finishing of the work.

132. Scantling.—All unwrought timber is to be of the scantling specified. The sizes specified for wrought work are the commercial sizes out of which the piece is to be cut; but all pieces wrought on both sides must not be more than $\frac{1}{8}$ inch less than the full specified dimension.

133. The scantling of constructional timbers, unless otherwise figured on the drawings, is to be as follows:

	Inches		Inches
Ground-floor joists	9 × 2	Main ridge	10 × 2
First-floor joists	10 × 2	Dormer ridge	8 × 2
Second-floor joists	9 × $2\frac{1}{2}$	Main hips	10 × 2
Wall plates	$4\frac{1}{2}$ × 3	Dormer hips	7 × 2
Rafters of main roof	$6\frac{1}{2}$ × $2\frac{1}{2}$	Valleys	11 × 3
Trimming rafters	8 × 4	Bearers of eaves soffit	3 × 2
Rafters of dormers	4 × 2	Studs	4 × 2
Eaves rafters	4 × 2	Heads and sills of quarter partitions	4 × 4
Roof ties (ceiling)	6 × 2		

134. General Clause.—The whole of the joiner's work shall be cut out and framed together as soon after the commencement of the work as possible and at least 2 months before being fixed. All glued joints must be cross-tongued and finished in the best possible manner without the use of glasspaper, and all joinery that is to be painted must be knotted and primed before leaving the workshop. All nails, sprigs, etc., are to be punched and puttied before the work is painted, and all doors and framings and both sides of the lock-rails of doors shall be double tenoned. Where moulded work is described, all external glazed panels, and all glazing to doors, fanlights, etc., must have movable beads fixed with brass cups and screws. The upper part of all sashed doors and framings is to be diminished in width. The contractor shall case up and protect all wooden stairs, floors, and other joinery where liable to injury during the progress of the works.

135. Framing, Etc.—The contractor shall perform all necessary framing, mortising, tenoning, grooving, matching and tonguing, jointing, rabbeting, and housing, and also all spiking. He shall also provide and fix all wrought-iron plates and screws that may be necessary or may be ordered by the architect.

136. Moulding.—All moulded work must be accurately worked to the full-size details supplied by the architect. If required, the contractor shall supply the architect with a piece of the moulding that he may test the accuracy of its contour. All mouldings, except where otherwise specified, are to be worked on the solid.

137. Templates and Casing.—The contractor shall provide all necessary centres for brick arches and under concrete floors and hearths and all necessary templates for this and other trades; care shall be taken that none shall be struck until the work has become thoroughly set and approved. He shall also provide and fix all necessary casing to protect stone and other projecting work from injury and all necessary rough splayed grounds to stop plastering.

138. Carbolineum.—All wall plates, ends of joists, or other parts of timber built into walls shall be coated with carbolineum or other approved preservative.

139. Spacing of Joists, Etc.—No joists, rafters, studs, or other similar timbers shall be spaced farther apart than 15 inches from centre to centre. All trimmers are to be $\frac{1}{2}$ inch thicker and all trimming joists 1 inch thicker than similar adjoining timbers.

140. Trimming.—The contractor shall perform all necessary trimming for stairs, hearths, dormers, trap-doors, and other similar openings, so as to leave a sufficient opening allowing for all linings, etc. All headers must be properly tusk-tenoned into trimmers, care being taken not to unnecessarily weaken timbers by the way in which they are cut.

141. Roof.—The roof is to be constructed, as shown on the drawings, with timbers of the scantlings figured, where not specified, properly framed and spiked together. Wall plates at angles are to be halved together and tied with dragon ties properly framed and tusk-tenoned together.

142. Partitions.—All stud partitions shall be formed of $4'' \times 2''$ quarters and braces and $4'' \times 4''$ head- and sill pieces properly framed and spiked together.

143. Strutting.—All floors having a greater span than 8 feet must have one row of herringbone strutting 2 inches by $1\frac{1}{2}$ inches.

144. Supports for Hearths.—Rough fillets 3 inches by 2 inches shall be fixed to trimmers and trimming joists to support concrete hearths.

145. Lintels.—The contractor shall provide and fix over all openings in walls wooden lintels of the full thickness of the wall and 1 inch in depth for every foot of span; but none shall be less than 3 inches with a bearing of $4\frac{1}{2}$ inches at each end.

146. Flats.—The flats over bays shall be formed with $4'' \times 2''$ bearers; they shall have all necessary furring-pieces covered with $\frac{3}{4}$-inch rough

boarding. The flats shall be prepared for lead and shall be laid with proper fall to the gutter at the edge.

147. Rafter Feet.—All rafter feet, where exposed, shall be cut and wrought to the detail given.

148. Main Eaves.—The eaves of the main roof shall be constructed as shown on the drawings with 4″ × 2″ rafters spiked to main rafters and 3″ × 2″ soffit bearers. The 9″ × 1″ fascia shall be rabbeted to receive the $\frac{3}{4}$-inch soffit boarding, which shall be perforated for ventilation to rafters. A 2″ × 2″ screed mould shall be used to cover the joint with the wall. The eaves bed mould is to be carried along as a tilting fillet under the hanging tiles of the gable to the back elevation, and also round the soffit of the overhanging gable to the principal front.

149. Barge Boards, Etc.—The barge boards, tie-beam, brackets, and half-timber work are to be of oak, both in the main gable and in the dormer gable. All work must be executed as shown on the detail drawings. Main-gable barge boards are to be of 11″ × 2″ ovolo moulded with a $4\frac{1}{2}$″ × 1″ moulded piece planted on and a 3″ × 2″ moulding scribed under the tiles. The tie-beam is to be 17 inches by 4 inches, weathered and shaped as shown. All vertical timbers must be 7 inches by 2 inches, rabbeted for plaster and with 3″ × 2″ fillets nailed on for lathing. They must be tenoned into the tie-beam and secured with square pegs left projecting. Brackets under gable projection, and the small brackets supporting the projection of the wall plates, are to be cut out of 6-inch stuff according to the detail drawings furnished. Barge boards of dormer gable must be 7 inches by $1\frac{1}{2}$ inches, moulded with 2″ × 1″ moulding scribed under the tiles. A 9″ × 3″ tie-beam, weathered and shaped, will be used, a small piece being fastened to it to form the soffit behind the tie-beam. The 5″ × 2″ vertical timbers are rabbeted for plaster and the brackets under the tie-beam are to be cut out of 4-inch stuff.

150. Bays on Garden Front.—The upper part of the small bay windows in the drawing- and morning-rooms shall be formed of framing as shown on Sheet No. 12. The roof over the seat shall be formed with two 6″ × 2″ pieces wrought on the under side and spiked together as beams to carry roof; 4″ × 2″ rafters and 3″ × 2″ ceiling joists shall be used and the ceiling and sides of the beam shall be cased with 1-inch boarding and screed moulds, as shown.

151. Roof Boarding and Battens.—The roofs shall be covered with $\frac{3}{4}$-inch rough boarding. On this fix felt as described in the tiler's specification and $1\frac{3}{4}$″ × $\frac{3}{4}$″ sawn tiling battens placed 4 inches from centre to centre. Similar tiling battens must be fixed to the dormer cheeks, and the vertical gable wall, where shown, is to be covered with tiling.

152. Flooring.—The flooring for the entrance hall and the three principal rooms will be 3″ × 1″ red deal grooved and tongued. Other

floors will be similar, but in batten widths rabbeted with splayed headings properly cramped together and securely nailed. The contractor must provide and fit 3″ × 1″ oak mitred borders to all hearths and sinking for front-door mat.

153. Wood Block.—The scullery floor is to be laid with $1\frac{1}{4}$-inch pitch-pine wood-block flooring laid in mastic on cement face of concrete. The blocks must be securely keyed together in a manner approved by the architect.

154. Staircase.—The staircase shall be formed throughout, as shown on the drawings, with $1\frac{1}{2}$-inch treads and 1-inch risers glued, blocked, and bracketed together on strong fir carriages and housed into a $1\frac{1}{2}$-inch moulded wall string. The other end of the riser is to be mitred with a 2-inch cut string. The moulded nosing of tread is to be returned, mitred, and stopped on itself, and the lower edge of the cut string is to be rabbeted to receive the plaster of the soffit. The joint between the plaster and the string will be covered by a 3″ × 1″ moulding. All newels on top floor and top landing are to be $4\frac{1}{2}$ inches square ; other newels are to be similar, but sunk on face, as shown.

Mahogany caps and pendants to the newels and a 4″ × 3″ mahogany moulded hand rail, to detail to be supplied, with all necessary ramps, shall be provided. Two-inch spiral turned balusters, of a design to be selected by the architect from suitable stock, must be provided and fixed. These must be housed into treads and hand rail. On the ground and first floors, form solid moulded curtail steps with veneered risers, as shown. Landings are to be formed with 7″ × 2″ bearers and 7″ × 3″ trimmer with newels halved on. Under the stairs, from the ground to the first floor, form a $1\frac{1}{2}$-inch square framing that is fixed into the rabbet of the outer string with a small screed mould to cover the joint ; at the bottom fix a 7″ × 1″ moulded skirting, as elsewhere.

155. Skirtings.—The contractor shall provide and fix 7″ × 1″ moulded skirtings to detail in all rooms except attics, which are to have 7″ × 1″ chamfered skirting.

156. Picture Mould.—The contractor shall provide and fix to dining-, drawing-, and morning-rooms a 3″ × 2″ moulded picture rail made according to the details furnished.

157. Fixing With Screws.—All floor boards and skirtings covering gas piping or wiring must be fixed with screws with brass cups for easy removal.

158. Cistern Cover.—A cold-water supply cistern with a cover made of 1-inch grooved-and-tongued boarding nailed to 4″ × 1″ chamfered battens shall be provided.

159. Vestibule Framing.—The vestibule framing shall be formed, as shown on the detail drawing, on 4″ × 2″ rough stud work securely framed together, with 1-inch panelling fixed on $\frac{3}{4}$-inch rough backing, with capping to match that of the remaining panelling in the hall, as described later. Panelling must be returned at jambs of windows and round jamb of arch and window recess. A 2-inch moulded door, with diminishing stiles and its upper part divided by $1\frac{1}{2}$-inch moulded bars into sixteen glazing squares, provided with movable beads secured by brass screws and cups, shall be placed in the vestibule. It will be hung on a pair of 4-inch brass steel-bushed butts to a 4″ × 2″ rabbeted and moulded frame with a $3\frac{1}{2}$″ × 2″ moulded architrave rabbeted to receive panelling and finishing on a shaped plinth block 7 inches high.

The transom over the door shall be formed by fixing the architrave, with the square outer member cut off, to the door head, having rough pieces 4 inches by $1\frac{3}{4}$ inches above; over this fix an 8″ × 1″ top board. The fanlight is to be 2 inches thick, moulded for glazing the same as the upper part of the door, and will have a $5\frac{1}{2}$″ × $1\frac{1}{2}$″ rabbeted and twice-moulded curved lining. It will be hung at the bottom on a pair of 3-inch butts to a 2″ × $\frac{1}{2}$″ plain fillet, and will open inwards. Fix as an architrave to the fanlight arches $\frac{3}{4}$-inch chamfered and shaped arch pieces, as shown. The window in the framing is to have $1\frac{1}{2}$-inch moulded folding casements, to be rabbeted on the meeting stile with $1\frac{3}{4}$-inch moulded bars and movable beads, as before. They are to be hung on a pair of 3-inch brass butts to a $5\frac{1}{2}$″ × $1\frac{1}{2}$″ rabbeted and twice-moulded frame, $5\frac{1}{2}$″ × $2\frac{1}{2}$″ similar head, with 8″ × 1″ twice-moulded piece over to mitre with top member of panel capping.

The sill is to be $5\frac{1}{2}$ inches by $2\frac{1}{4}$ inches, twice rabbeted and moulded, and twice grooved for 2″ × 1″ moulded nosing, with a small mould underneath. The fanlight, etc., over it is to be the same as that over the door. An arch is to be formed at the other side of the door, to be open from the ground upwards to the soffit of arch. All jamb linings are to be formed of 1-inch stuff mitred and rabbeted to the panelling; the soffit of the arch is to be similar. A 7″ × 1″ moulded architrave is to be fixed mitred round the base of the framing, as elsewhere, but it will be stopped against the plinth blocks of the door architrave.

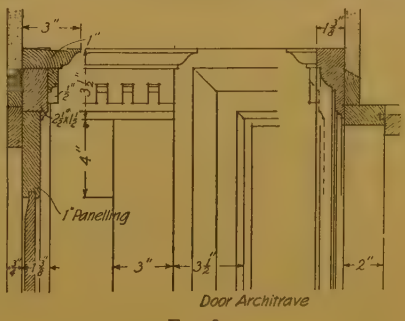

Fig. 6

160. Hall Panelling.—A 1-inch panelled framing, with arrises rounded and a capping, shall be fixed round the hall, as shown in the sketch (Fig. 6). A 5″ × 2″ pilaster shall be placed on each side of the staircase opening and

the capping shall be mitred round the same. The panelling shall be carried to the ceiling beam, which is to be formed of 1-inch casing and will be 12 inches deep below ceiling level; the carved brackets will be cut out of 7″ × 5″ material. A 7″ × 1″ square plinth is to be fixed to the pilaster.

161. External Doors.—The front-entrance doors are to be of $2\frac{1}{4}$-inch oak with three panels, and on the outside shall be moulded on the solid with raised panels. The inside is to be square, but with a small bead planted on all round panels. The door is to be hung on $1\frac{1}{2}$ pairs of $3\frac{1}{2}$-inch brass ball-bearing butts to a $5\frac{1}{4}$″ × 4″ rabbeted and moulded oak frame, which is to be stub-tenoned to the sill. The transom is to be 7 inches by 5 inches, moulded, twice rabbeted, weathered, and check-throated, the lowest moulding being mitred with moulding on door frames. The moulded fanlight over transom is to be 2-inch with $1\frac{1}{2}$-inch glazing bars; the fanlight is to be hung at bottom and to open inwards, and its lower rail is to be rabbeted as a weather check, as shown on the detail drawing. The frame will be the same as for door. A $2\frac{1}{4}$″ × $1\frac{1}{2}$″ moulded architrave will be fixed on the inside all round the opening and across the transom.

At the entrance from the garden there shall be a 2-inch three-panelled door; the upper panel is to be prepared for glass and have movable beads and brass cups and screws; the lower panels are to be square. The door is to be hung on a pair of $3\frac{1}{2}$-inch wrought-iron butts to $4\frac{1}{2}$″ × 3″ rabbeted and moulded frames, which are to be stub-tenoned to the sill. A $1\frac{1}{4}$-inch bead-and-butt two-panelled movable shutter with two brass stubs and plates and 3-inch brass thumbscrews shall be provided. The back door to scullery shall be a $1\frac{3}{4}$-inch two-panelled framed door, filled with $\frac{3}{4}$-inch V-jointed match boarding, and hung on a pair of $3\frac{1}{2}$-inch wrought-iron butts to a $4\frac{1}{2}$″ × 3″ rabbeted and beaded frame that is stub-tenoned to the sill. The doors to the servants' w.c. and furnace room are to be $1\frac{1}{2}$-inch ledged-and-braced doors, and are to be hung on strong wrought-iron T hinges to $4\frac{1}{2}$″ × 3″ rabbeted frames that are stub-tenoned to the sill.

162. Internal Doors.—All doors from the morning- and drawing-rooms, the pantry, lobby, and from the dining-room to the hall are to be 2-inch six-panelled moulded doors with raised panels and bolection mouldings on the room side. They are to be hung on a pair of 4-inch brass butts to framed linings, as shown on the detail drawings. The linings will have a $3\frac{1}{2}$″ × $1\frac{1}{2}$″ moulded architrave as shown. The architrave on the hall side is to be rabbeted at the back to take the panelling. The glazed doors to the kitchen and pantry are to be $1\frac{3}{4}$-inch three-panelled square doors. The upper panel is to be prepared for glass with movable beads, which are secured by brass screws and cups. These doors will hang on a pair of $3\frac{1}{2}$-inch wrought-iron butts to $1\frac{1}{2}$-inch twice-rabbeted linings with a 2″ × 1″ plain architrave, the arrises of which are rounded.

The entrances to the lavatory and to the basement will be fitted with $1\frac{3}{4}$-inch four-panelled moulded and square doors. The lavatory doors

will be hung on a pair of $3\frac{1}{2}$-inch wrought-iron butts to $1\frac{1}{2}$-inch twice-rabbeted linings that are secured to the grounds and have a small screed mould to cover the joint with the plaster. The basement door is to be hung to a $4'' \times 3''$ rabbeted frame, and to a newel carried down to the floor as a frame, having the small screed mould. The upper panels of the door to the basement are to be glazed with obscure glass. Between the kitchen and scullery hang a $1\frac{3}{4}$-inch four-panelled square door on a pair of $3\frac{1}{2}$-inch wrought-iron butts to $1\frac{1}{2}$-inch twice-rabbeted linings that have a $2'' \times 1''$ plain architrave with rounded arrises.

163. The doors to the larder and coal cellar are to be $1\frac{3}{4}$-inch four-panelled square doors hung on a pair of $3\frac{1}{2}$-inch wrought-iron butts to a 1-inch lining that has a small $\frac{1}{2}$-inch stop nailed on and a $2'' \times 1''$ architrave as before. The door to the furnace room is to be the same as for the pantry and kitchen, but it is to be hung to 1-inch linings that are stop-nailed on. The architrave is to be 2 inches by 1 inch. At the entrance to the wine cellar, hang a $1\frac{1}{2}$-inch four-panelled square door on a pair of $3\frac{1}{2}$-inch butts to a 1-inch lining, the same as for the furnace room. For the space under the ground-floor rooms, hang a ledged door on 18-inch cross-garnets to a $4'' \times 2''$ frame to which a stop is nailed.

The first-floor rooms are to be fitted with $1\frac{3}{4}$-inch five-panelled moulded doors hung on a pair of $3\frac{1}{2}$-inch wrought-iron butts to a $1\frac{1}{2}$-inch twice-rabbeted lining that has a $3'' \times 1\frac{1}{2}''$ moulded architrave. This finishes on a shaped plinth block 7 inches high. The linen cupboard is to have a $1\frac{3}{4}$-inch three-panelled moulded square door hung like the other doors on the first floor. The door to the cupboard in the dressing-room will be similar to this last. All doors on the top floor must be $1\frac{3}{4}$-inch four-panelled and square. They will be hung on a pair of $3\frac{1}{2}$-inch wrought-iron butts to a 1-inch lining, to which a $\frac{1}{2}$-inch stop is nailed. The linings will have $2'' \times 1''$ architraves with rounded arrises.

164. Cupboards.—In the pantry, form a cupboard with a $1\frac{1}{2}$-inch framed front and side and $\frac{3}{4}$-inch matched boarding on the wall. The framing is to be rabbeted for $1\frac{1}{2}$-inch square panelled doors, which are also to be rabbeted and hung on a pair of 3-inch butts. The lower part of the cupboard is to be wider than the upper and will have a $1\frac{1}{4}$-inch top that has a rounded edge. The height of the lower part is to be 3 feet above the floor, and the bottom is to be formed of 1-inch rabbeted boarding laid on rough bearers 3 inches above the floor, with a splayed plinth. This part will have $1\frac{1}{2}$-inch square folding doors with rabbeted meeting stiles. In the upper part of the cupboard provide four tiers of 1-inch deal shelving on proper bearers. The top of cupboard is to be formed of $\frac{3}{4}$-inch rabbeted boarding, which is to be finished round top with a small moulded cornice.

The scullery cupboard is to be formed similarly to the pantry cupboard, but in one height and with four tiers of shelving. The cupboard in the

bedroom on the first floor is to be 8 feet high and formed of $1\frac{1}{2}$-inch material and panelled. The front part is to be rabbeted and hung as a door on a pair of 3-inch wrought-iron butts, and the panels are to match, in height, those of the door. As the lower part of the cupboard is to be formed as a hanging cupboard, it will have a chamfered hanging rail and six heavy brass hat-and-coat hooks. Over this rail a 1-inch deal shelf is to be placed, and the top of cupboard finished with a 1-inch rabbeted boarding and a moulded cornice, formed according to the details to be furnished.

165. The cupboard in the dressing-room is to be similar to that just described for the bedroom. In the linen cupboard there are to be placed three tiers of open shelving formed of $3'' \times 1''$ battens spaced 1 inch apart on proper bearers over the hot-water tank. This tank is to be fixed in the bottom of the cupboard on rough bearers. The cupboard in the top-floor bedroom is to have $1\frac{1}{2}$-inch four-panelled square doors hung folding with rabbeted meeting stiles and butts, as the other doors, and with a $2'' \times 1''$ plain architrave.

166. Shelving.—The contractor shall provide and fix, where directed, on proper fir bearers, 20 feet run of 1-inch deal shelving 18 inches wide.

167. Windows.—All windows in the dining- and morning-rooms, except in the bay, and in the hall, vestibule, and bedroom over the dining-room, are to be $1\frac{3}{4}$-inch moulded casements with 1-inch glazing bars. They are to be hung on a pair of brass butts to $5\frac{1}{4}'' \times 2\frac{3}{4}''$ rabbeted, check-throated, and moulded frames. The head is to be wedged securely to the stone jambs and mullions. The sill is to be $7'' \times 3''$ oak, twice rabbeted, weathered, moulded, check-throated and grooved for window board and for water bar. The water bar must be of $1'' \times \frac{1}{4}''$ galvanized iron, and must be set in white lead in the wooden sill and in cement in the stone. Sills above the transoms are to be similar, but 7 inches by $2\frac{1}{2}$ inches; casements above transoms are to be top hung to open outwards. The contractor shall fix $3\frac{1}{2}'' \times 1\frac{1}{4}''$ rabbeted-and-moulded window boards, with a $1\frac{1}{2}'' \times 1''$ moulding under, rabbeted to fit into the groove in the window board. The inside face of the mullions and transoms shall be faced in $\frac{3}{4}$-inch rough backing with a $\frac{3}{4}$-inch moulded-and-panelled casing, as shown on Sheet No. 13. Round the windows shall be placed a $2\frac{1}{4}'' \times 1\frac{1}{2}''$ moulded architrave, which is to be rabbeted to cover the edge of the casing over the stone. Under these windows, fix, as shown, a 1-inch panelling, similar to that in the hall, on the $\frac{3}{4}$-inch rough backing; the skirting is to be mitred round same at the base.

Staircase windows are to have $4\frac{1}{2}'' \times 3''$ rabbeted-and-moulded frames and head, $4\frac{1}{2}'' \times 3''$ twice-rabbeted and twice-moulded mullions, $4\frac{1}{2}'' \times 3''$ sunk, weathered, check-throated, and twice-moulded transoms, and a $4\frac{1}{2}'' \times 4''$ sunk, weathered, and check-throated sill grooved for water bar. The head of the first-landing window is to be segmental, to be hung with

$1\frac{3}{4}$-inch moulded casements, as previously described. The inside of the window is to be surrounded with $\frac{3}{4}$-inch wrought grounds and $2'' \times 1\frac{1}{2}''$ moulded architrave. The coal cellar and furnace room are to have $1\frac{1}{2}$-inch casement windows hung to $4\frac{1}{2}'' \times 3''$ rabbeted frames and head, and a $4\frac{1}{2}'' \times 3''$ sunk, weathered, and check-throated sill grooved for water bar.

168. Fixed Casements. — All fixed casements are to be bedded securely in white lead and fixed with screws.

169. Dormers.—All dormer windows are to be formed with $1\frac{3}{4}$-inch casements 5 inches by 3 inches. The mullions are to be 7 inches by 5 inches and twice rabbeted; the angle posts, also, are to be rabbeted. Fix a $5'' \times 2''$ frame at the head and a $4'' \times 4''$ head over this to act as a plate for the rafters. The sill is to be 9 inches by 3 inches, and of oak, sunk, weathered, and throated. All stud work under the sill of the dormers is to be 4 inches by 2 inches with a $4'' \times 3''$ head-piece; all stud work for the dormer cheeks is to be 4 inches by 2 inches halved to trimming rafter and carried down to the $4'' \times 3''$ sill piece on floor joists. The $4'' \times 4''$ head is to act as a plate for the rafters.

170. Bay Windows.—The small bay windows in morning- and drawing-rooms are to be formed with frames against the wall out of $7'' \times 7''$ material, sunk, splayed, rabbeted, check-throated, and moulded. The angle frames are to be similar, but formed out of $7'' \times 5''$ material. They will be fitted with $1\frac{3}{4}$-inch moulded casements, which have 1-inch glazing bars and are hung on a pair of brass butts. The casements on the front faces of the bays are to be folding and rabbeted on their meeting stiles; the heads are to be 6 inches by 4 inches rabbeted and moulded; and the sill is to be 9 inches by 4 inches, sunk, weathered, throated, check-throated, twice rabbeted, and moulded. Round the outside of the bay windows a $4'' \times 1''$ moulded fascia is to be fixed; this is to be housed into the sill, as shown. Above the head of window, a similar fascia, but 9 inches by 1 inch, is to be fixed; to this the gutter is to be secured. Round the inside of the window fix a $3\frac{1}{2}'' \times 1\frac{1}{2}''$ architrave and form a seat round the bay, as shown, with a $9'' \times 1''$ riser, a $7'' \times 1''$ moulded skirting, as elsewhere, and a $1\frac{1}{4}$-inch seat, with rounded nosing and a small mould under. Part of the seat is to be hinged to open on brass butts, as shown. The seat is to have a $1\frac{1}{4}$-inch panelled back, which is to be finished under a 1-inch moulded window board, which is rabbeted and fitted into a groove in the sill. The seat is to be supported on $3'' \times 2''$ fir bearers, properly framed together, and the space between the bearers, to which access is obtained from the hinged opening in seat, is to be lined with $\frac{3}{4}$-inch close boarding, splayed fillets being placed over the angles.

171. The segmental bay window in the drawing-room is to be formed with $1\frac{3}{4}$-inch casement windows, as before, but all will be circular on plan. The heads are to be 4 inches deep and rabbeted and moulded; the mullions

are to be 5 inches by 4 inches and similarly rabbeted and moulded. The transom is to be 5 inches deep, weathered on the upper edge; the sill is to be 4 inches deep, as previously described, but circular. The window board and panelling are to be placed below this window the same as to other casement windows, but all will be circular. The ceiling of the bay window is to be formed of 3″ × 2″ ceiling joists; the flat over it is to be of 4″ × 2″ bearers and so laid as to fall to the gutter at the back against the wall. A wooden cornice is to be formed with a 1-inch fascia and 3″ × 1½″ necking mould round the bay at the top according to the detail drawings furnished.

172. Sash Windows.—All first-floor windows and those of the kitchen and pantry are to be double-hung sashes with cased frames formed of 1¼-inch pulley stiles. They will have a 1-inch inside and a 1¼-inch outside lining, ½-inch backing, ½-inch parting bead and parting slip, and ¾-inch jamb lining; these are to be rabbeted to grooves in the frame and in ¾-inch wrought and moulded ground. Round the inside of the window is to be fixed a 2¼″ × 1¼″ moulded architrave. The kitchen and pantry windows are to have the jamb lining extended square to the face of the rough plaster ground, and will have a 2″ × 1″ plain architrave the same as the doors. The joint between the jamb lining and the sash frame is to be covered by a small screed mould, and the sill is to be of 7″ × 4″ oak, sunk, weathered, check-throated, and grooved for a water bar. All sashes are to be 2-inch moulded with a 1-inch moulded glazing bar and 1¼″ × ¾″ moulded fixing beads; the upper sashes will have moulded horns. The sashes are to be hung with Samson spot sash line, or other make approved by the architect, and to have 2½-inch brass-faced axle pulleys, mortised into pulley stile, and cast-iron sash weights. These windows are to be fixed with the full width of frame exposed on the outside; the joint with the brickwork is to be covered by a 2″ × 1¼″ mould.

All windows in the scullery, ground-floor lavatory, servants' w.c., and larder are to have 1¼-inch pulley stiles, 1-inch inside and outside linings, ½-inch back lining, ¼-inch parting bead, and 1½-inch double-hung sashes with 2-inch brass-faced axle pulleys. The inside lining is to be grooved for plaster, which will be returned round the jamb and soffit of the head. A 1-inch window board, with rounded nosing and rabbeted to fit groove in 7″ × 3″ sunk, weathered, check-throated oak sill, and which is also grooved for water bar, is to be put in place.

173. Dining-Room Recessed Fireplace.—All joinery round the recessed fireplace in the dining-room is to be formed as shown on Sheet No. 11. It is to be glued, blocked, bracketed together, and securely fixed on ¾-inch rough backing. The panelling is to be 1 inch square with 4½″ × 2″ pilasters that have shallow sunk panels in the upper part and capping and necking mitred round. A 5″ × 2½″ plinth block is to be fixed to the pilaster, which is to be continued above capping to ceiling

and is to have 4″ × 2½″ brackets carved according to the architect's directions. Allow the sum of £5 for carving. A 4″ × 3¼″ architrave is to be formed round the fireplace; this is built up and rabbeted on the top to allow of the insertion of the 1-inch frieze, which is also to be fitted to the rabbet of the mantelshelf. The mantelshelf is to be 1¼-inch, moulded, rabbeted, and supported on a 1½-inch rabbeted piece over the 3″ × 1½″ rabbeted bracket pieces.

The ceiling is to be encased, as shown, with ¾-inch stuff rabbeted and mitred together, as necessary, on rough bracketing. Small screeds shall be used to cover re-entrant angles. As shown, the small frieze and moulded cornice will be formed out of 1-inch stuff on the face of the bracketing round the rolled-steel joists across the opening. All windows in the recess are to be 1¾-inch moulded casements with 1-inch bars hung to 4½″ × 3″ rabbeted, check-throated, and moulded frames and head; these are to be grooved to receive the rabbeted end of the 1-inch lining. The sill is to be of 4½″ × 3″ oak, sunk, weathered, check-throated, moulded, and grooved for the water bar. A 1¼-inch moulded window board and 7″ × 1″ moulded fascia are to be fixed underneath. The seats are to be formed in a similar manner to those specified in the morning- and drawing-room bays, with framed and shaped ends formed out of 1½-inch stuff. All work must be in exact accordance with the detail drawings to be supplied by the architect.

174. Wooden Mantels.—A p.c. sum of £25 for wooden mantels is to be allowed. One is to be fixed in the drawing-room and one in the morning-room. The mantelshelf in kitchen is to be 1¾-inch and have rounded arrises and corners; a small screed mould is to be fixed under the projection.

175. Sinks and Draining Boards.—The sink in the glass pantry is to be of 1¼-inch wrought deal, glued and dovetailed. The sink will be 2 feet 6 inches by 1 foot 6 inches by 1 foot deep, with a 1½-inch dovetailed bottom dished out to the centre outlet. A 2″ × 1¼″ rounded nosing shall be placed on the front edge and the sink shall be prepared for a lead lining. A 1½-inch grooved deal draining board, laid sloping to the sink and with a 2″ × ½″ rounded fillet projecting above surface of board on three sides, shall be supported on 3″ × 2″ wrought-and-framed bearers and fixed at the sides on similar bearers. A 1-inch grooved-and-tongued and battened loose cover to the sink with two black-iron ring handles set flush in same shall be provided. The space under the sink shall be encased with 1½-inch square-framed cupboard fronts, parts of which are rabbeted and hung as doors. A similar draining board shall be provided for the scullery, but it is to be placed on 3″ × 2″ wrought-and-framed bearers.

176. Dresser.—The kitchen dresser is to be of wrought yellow deal, 6 feet long in two heights, framed and glued together and securely plugged to walls. The lower part is to be 3 feet high and have a top formed of

$1\frac{1}{2}$-inch grooved-and-tongued boarding with 6″ × 1″ skirting against wall at back. Arrises of edge are to be chamfered slightly and corners rounded. The dresser is to be supported on four 3″ × 3″ square legs, $2\frac{1}{2}$″ × 2″ rails under top, and 3″ × 2″ rails under drawers. Immediately under the top are to be formed three drawers 10 inches deep with $1\frac{1}{4}$-inch skeleton framing between and oak runners. Drawers are to be formed with 1-inch fronts and $\frac{3}{4}$-inch backs, sides, and bottoms dovetailed and rabbeted together and fitted to each with two deal turned knobs secured with buttons on the inside. Bottom of dresser is to be formed with $1\frac{1}{4}$-inch grooved-and-tongued blacked pot board, with rounded nosing and 1-inch riser on rough bearers. Against the wall at the back is to be fixed a 6″ × 1″ skirting. Upper part of dresser is to be formed with $1\frac{1}{4}$-inch shaped standards housed into top of lower part of dresser. Between standards 1-inch shelving is to be fixed, as shown in the sketch (Fig. 7). This is to be housed into standards and supported on wrought-iron brackets screwed to framing against wall. Bottom shelf is to be 5 inches wide, the next 6 inches, and the next 7 inches. Each is to have a sinking for plates, while one horizontal rail of framing is to be placed at the back between every two shelves. Top of dresser is to be 8 feet above floor and formed with a 3″ × 1″ fascia flush with the face of the standards, a 1-inch top board, and small cornice mould. The contractor is to provide and screw into edges of shelves four dozen $1\frac{1}{4}$-inch brass cup hooks.

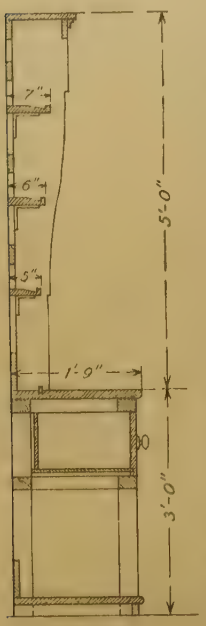

Fig. 7

177. Larder Shelves.—The larder is to have two shelves of the best quality of Welsh slate $1\frac{1}{2}$ inches thick and 2 feet wide. These are to be pinned into the brick walls and supported in the centre by slate brackets.

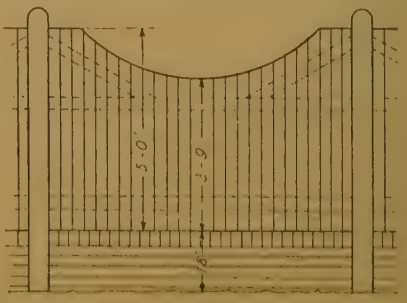

Fig. 8

178. Fences and Gates. The contractor shall provide and fix round the site a straight cleft-oak pale fencing, 6 feet high. Along the front it shall be shaped on top as shown in the sketch (Fig. 8), and shall be placed on an 18-inch dwarf wall with bull-nosed blue-brick coping built in between the posts of the fence. The posts

are to be 6 inches by 4 inches, except along the road frontage, where they are 6 inches by 6 inches and embedded 3 feet in ground with charred ends. The pales are to be $4\frac{1}{2}$ inches by $\frac{1}{2}$ inch, lapped 1 inch, and nailed with copper nails.

179. The gates are to be of oak in two widths, as shown in the sketch (Fig. 9). They are to be 3 inches thick, have 6″ × 3″ hanging stiles, 5″ × 3″ meeting stiles, a 7″ × 3″ top rail, a 9″ × 3″ bottom rail, and 5″ × 3″ braces with curved top pieces 3 inches thick, as shown. All are to be tenoned properly and framed together with pegs. The spaces between the framing are to be filled in with $1\frac{1}{2}$-inch square bars. Each gate is to be hung to a 9″ × 9″ post that has a 6″ × 3″ half post of fence abutting at the back, on patent cup-and-ball hinges; the upper hinge is to be 24 inches long and the lower hinge 18 inches. A collapsible cast-iron stop is to be provided for the gates, one of which is to have a small iron toe to lift the stop. A $\frac{3}{4}$-inch wrought-iron rod stay, with a hook end that will fit in the eye fixed to one gate, shall be fastened to a 3″ × 3″ oak post securely fixed in the ground; a heavy black-iron gate latch shall be fixed to the other gate. Two 3″ × 3″ oak posts shall be securely bedded in the ground; each shall be provided with a catch that will hold the gates open.

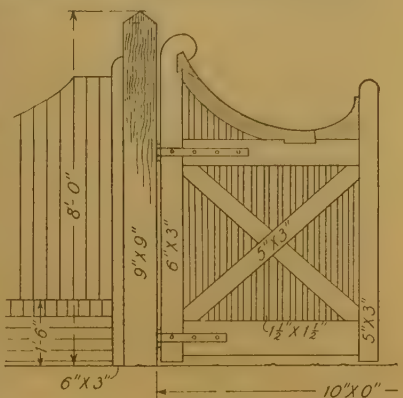

FIG. 9

IRONMONGER

180. General Conditions.—The contractor shall furnish all the rough ironmongery necessary to execute the whole of the carpenter's and joiner's work in a thoroughly sound and satisfactory manner and to the entire satisfaction of the architect. All brass work shall be secured with brass screws, and all gunmetal work with gunmetal screws. The contractor shall further supply and fix the items of finished ironmongery already mentioned in the specification of other trades, even though the description of such articles is not repeated here. All finished ironmongery must be from an approved manufacturer and selected by the architect, should he so desire.

181. Door Fittings.—The main-entrance door shall be fitted with a cylinder night latch of the Yale pattern and three keys provided for same;

it shall also be fitted with a 6-inch drawback lock of extra strong make with stop-action, two wrought-iron barrel bolts, one 12 inches at bottom engaging with a socket in the threshold, and one monkey-tail bolt engaging with a socket on the transom. A heavy wrought-iron door chain engaging with a slide fitting on the inside face of the door shall be fixed on the door frame, and a combined letter plate and handle, the p.c. of which is 25s., shall be fixed on the outside of the door. The door shall be perforated and a brass-wire letter cage hung on the inside.

To vestibule door the contractor shall fix one 6-inch brass mortise lock with gunmetal roller bolt and four levers, the p.c. of which is 7s. 6d. The furniture will consist of a brass lock-plate and escutcheon and heavy cast-brass handles with fast roses, the p.c. of which is 20s. complete. The doors to the dining-, drawing- and morning-rooms and the lobby to pantry are to have similar locks and furniture. The doors to the kitchen, glass pantry, scullery, larder, and internal door to furnace room are to have 6-inch two-bolt three-lever rim locks with brass furniture; p.c. 5s. 6d. each. The door to the coal cellar is to have a 6-inch dead lock and the cupboard in the scullery to have a small cupboard dead lock. The back-entrance door to the scullery and the door to the furnace room are to have heavy rim locks with brass furniture and two 12-inch barrel bolts. Door to servants' w.c. is to have strong Norfolk latch and 8-inch barrel bolt and hasp staple and padlock on the outside. The glazed door under stairs near garden entrance will have a 6-inch mortise lock and brass furniture, the p.c. of which is 10s. 6d. each complete, and brass finger plates, the p.c. of which is 7s. 6d. The lavatory door is to have a brass flush latch and a 6-inch brass barrel bolt. The garden-entrance door will have a 6-inch brass mortise lock and brass handles, the p.c. of which is 10s. 6d. each complete, and two 12-inch barrel bolts.

182. All bedroom doors on the first floor and to the bathroom, w.c., linen cupboard, and cupboard in dressing-room must have $5\frac{1}{2}$-inch mortise locks with three levers and brass bolts. Each door shall be fitted with heavy cast-brass door handles and finger plates selected by the architect, the p.c. of which will be 10s. 6d. each complete. The cupboards will only require finger plates on one side, so a p.c. of 7s. 6d. for two cupboard doors only is allowed. The cupboard in the bedroom is to have similar brass fixed handle and small cupboard dead lock. The doors to the top-floor bedrooms are to have rim locks and brass furniture and finger plates, the p.c. of which will be 7s. 6d. each complete. The cupboard doors shall have a small flush bolt on the edge of one leaf of doors and a fixed brass handle and cupboard dead lock on the other.

183. Casement-Window Fittings.—All side-hung casement windows shown on the drawings are to open, except those of the furnace room, coal cellar, and top-floor bedrooms; they are to be hung on a pair of 3-inch wrought-iron butts and have heavy brass or gunmetal cockspur

and pegstay fasteners, the p.c. of which is 7s. 6d. complete. The vestibule screen casements are to have brass butts. The folding casements to the drawing- and morning-room bays and vestibule screen are to have only one cockspur to a pair of casements; this will engage with a catch on the other casement, but the casement closing first is to have two flush brass bolts on the closing edge. The casements above the transoms that are shown to open are to be top hung to open out with a brass swivel stay, the p.c. of which will be 4s. The top-floor casements that are to open will have a wrought-iron cockspur and pegstay, the p.c. of which will be 5s. The coal-cellar and furnace-room windows will have similar fastenings, but lighter.

184. Sash Fasteners.—The contractor shall provide and fix to all sashes solid brass sash fasteners of an approved type, the p.c. of which will be 2s. 3d. each.

TILER

185. Tiles.—All the tiles and ridges shall be well burnt, true in shape, and equal to the samples that must be submitted and approved before the work is commenced.

186. Tile Roofing.—All the roofs shall be covered with first-quality red hand-made Broseley or other approved roofing tiles, with nibs. The tile to be used shall be selected by the architect from samples obtained by the builder. The tiles shall be nailed every fourth course with $1\frac{3}{4}$-inch galvanized nails and laid to a 4-inch gauge. The contractor shall provide for a double course at eaves and for cutting to valleys, dormers, chimneys, and elsewhere, as required.

187. Hip Tiles.—The hip tiles shall be purpose made, securely nailed with 2-inch galvanized nails, and pointed in lime mortar.

188. Tile Ridges.—The tile ridges shall be half round, bedded in hair mortar, jointed, and pointed in cement. All cutting must be done where required.

189. Tile Verges.—The verges of gables shall have an under course of tiles laid flat, and all shall be properly pointed in cement.

190. Vertical Tiling.—The vertical tiling on the gable of the back elevation shall be executed with similar tiles and workmanship. It shall be double-nailed to battens, as before specified. All necessary cutting to angles shall be done as required. The dormer cheeks shall be tiled and double-nailed to battens, as before specified.

191. Sheathing Felt.—All the roofs, except eaves projection, shall be covered with best-quality inodorous hair roofing felt, which shall be properly nailed to the boarding.

HEATING AND VENTILATING ENGINEER

192. A p.c. sum of £100 shall be allowed for the heating, which shall be treated as subcontractor's work. The contractor shall afford every facility to the engineers for the carrying out of their work, and shall attend on them, cut away for and make good after them as necessary throughout.

SMITH AND FOUNDER

193. General Conditions.—Ironwork and steelwork generally are to be of English manufacture and of the best quality from a firm approved by the architect.

194. Chimney Bars.—The contractor shall provide all necessary chimney bars mentioned in the bricklayer's specification, which must be turned up and down at ends, and the kitchen chimney bar which will project through to the outside of the jamb on one side; he will also provide the manhole covers specified in the drainlayer's specification.

195. Railing.—The contractor shall provide and fix round the outside stairs to the furnace room a wrought-iron railing of $\frac{3}{4}$-inch square bars fixed with countersunk screws to a 2″ × 1″ convex top rail and a 1″ × 1″ bottom rail. Every 3 feet this railing will have $1\frac{1}{4}$-inch square standards, which are let into holes sunk in a stone curb with molten lead, as shown in the sketch (Fig. 10). A gate of approved design shall be hung at the top of the steps, and shall be supplied with a latch, padlock, and chain.

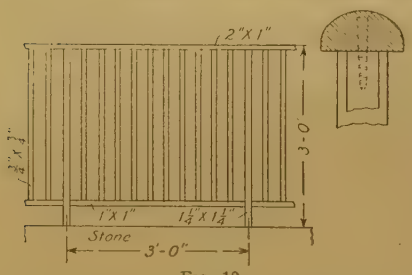

Fig. 10

196. Wrought-Iron Corbels.—Strong wrought-iron corbels shall be provided to support the wall plates for the roofs over the small bay windows and in such other situations as may be necessary.

197. Rolled-Steel Joists.—The contractor shall provide rolled-steel joists, from an approved manufacturer, of the full size and weight here specified. They must have a bearing of at least 6 inches at each end, on 3-inch York-stone templates, except when embedded in a concrete lintel. Over the curved bay in the drawing-room there shall be placed two 8″ × 4″ rolled-steel joists weighing 48 pounds per foot; one of these joists is to have a 4″ × 3″ angle steel riveted to the flange to form a bearing for the floor joists. Over the small bays in the drawing- and morning-rooms shall be fixed two 4″ × 3″ rolled-steel joists that weigh $9\frac{1}{2}$ pounds

per foot. Over the recessed fireplace in the dining-room two 8″ × 6″ rolled-steel joists weighing 35 pounds per foot shall be fixed, and in the concrete lintel over the entrance door two 4″ × 3″ rolled-steel joists weighing $9\frac{1}{2}$ pounds per foot shall be fixed.

198. Rain-Water Gutter.—The contractor shall provide and fix a $4\frac{1}{2}$″ × $4\frac{1}{2}$″ heavy cast-iron moulded eaves gutter to the main eaves. It must be put together in red lead and bolted and properly screwed to the fascia, and must be provided with all necessary stopped ends and outlets. The gutter to the eaves of the dormers and roof of back additions is to be of 4-inch heavy cast iron, half round in section; it will be supported on wrought-iron brackets screwed to the rafters' feet. Round the bays and to the roof, over the seat on the garden front, a $3\frac{1}{2}$″ × $3\frac{1}{2}$″ cast-iron moulded gutter is to be screwed to the fascia.

199. Rain-Water Pipes.—All rain-water down pipes are to be heavy 4-inch cast-iron socketed pipes. They are to be jointed in lead, with ears cast on for fixing, and shall have all necessary bends, swannecks, elbows, junctions, and shoes at the bottom to discharge over the gully. All down pipes are to be fixed with large rose-headed nails blocked 2 inches away from the face of the wall.

200. Heads.—The contractor shall provide and fix a cast-iron rain-water head, the p.c. of which will be 10s., to receive the water from the roof of the back additions and the main roof near the back door; also on the main front a cast-iron head, the p.c. of which will be 20s.

201. Soil Pipe.—All vertical soil pipes shall be 4-inch cast-iron pipes of not less weight than 54 pounds per 6-foot length, including the beaded spigot and socket; they shall be coated with Dr. Angus Smith's solution. All joints are to be made with molten lead properly caulked, and the pipes are to be fixed by means of wrought-iron straps bolted round the pipe and built into the wall.

202. Connections.—The connection of the soil pipe to the drain is to be made by inserting the spigot of an iron pipe into an upturned socket of stoneware drain and the joint made in neat Portland cement. The connection of the stoneware trap of the closet with the soil pipe is to be made by means of a 4-inch cast-iron connection jointed to the soil pipe in lead and to the closet trap in cement.

203. Vent Pipes.—The three vent pipes shall be of cast iron, as described for soil pipes. They shall be carried up to at least 3 feet above the dormer eaves and finished with copper-wire domed covers secured by copper lugs to the open end of the pipes.

204. Stoves and Ranges.—The p.c. sum of £60 shall be allowed for the kitchen range, stoves, and mantel registers throughout the house; these will be selected by the architect.

PLUMBER

205. General Conditions.—The contractor is to provide all necessary copper nails, solder, wedges, wall hooks, tacks, and lead collars necessary for all work to be carried out under this specification. All plumbing work is to be done in accordance with the regulations of the local authorities and the water company.

EXTERNAL PLUMBER

206. Sheet Lead.—The sheet lead is to be the best milled lead of uniform thickness, free from cracks or other defects, and weigh the full amount specified per superficial foot. Angles, corners, and bends must be carefully dressed over in such a way that the metal shall not be unduly thinned in any part.

207. Flats.—The flat over the segmental bay is to be covered with 7-pound lead properly dressed over the woodwork and close copper-nailed along edge of wooden cornice. A small gutter is to be formed at the back and the lead turned up 6 inches against the wall; it is to be finished with a lead cover flashing tucked into the joints in the brickwork and pointed in cement. A dished outlet is to be formed for the rain-water and the lead properly dressed round same; this is to be connected to a branch of the cast-iron down pipe by means of a short lead pipe wiped to the gutter outlet. The flat over the small bays is to be formed with 7-pound lead dressed over the edge of the cast-iron gutter and turned up 6 inches against the wall at the back. It is to be finished with a cover flashing tucked into the brick joint and pointed in cement.

208. Gutters.—The gutters behind the chimney stacks are to be formed of 6-pound lead and are to fall both ways from the centre of the stack. They shall be 6 inches wide at the narrowest part. The lead must be dressed over the tilting fillet, turned up 6 inches against the back of the chimney, and finished with a cover flashing pointed in cement.

209. Flashings.—Where sloping roof surfaces abut against vertical faces, such as chimney stacks and dormer cheeks, a 4-pound lead soaker shall be provided for each tile; it is to be 3 inches longer than the tile and shall lie 4 inches under the tiles and stand up 5 inches against the vertical faces, being covered, in the case of dormer cheeks, by the tile hanging, but in the case of chimney stacks, by 5-pound lead stepped flashings 8 inches wide, which must be properly tucked into the joints and pointed in cement. The aprons in front of the chimneys and dormers are to be of 5-pound lead and shall lie 6 inches down the slope of tiles. In the case of the dormers they shall be turned under the sill and copper-nailed; in the case of the chimneys they shall stand up 6 inches, be tucked into joint, and pointed in cement.

210. Lead Slates. — Where iron vent or other iron pipes pass through the roof, they are to have a lead sleeve closely bossed round the pipe and a 7-pound lead slate soldered on. If the pipe is of lead, the slate may be soldered to it direct.

INTERNAL PLUMBER

211. Lead Pipes.—All lead pipes are to be hydraulic drawn and of equal substance throughout. They are to be jointed with wiped joints and are not to be of less weight per linear yard than is given in Table I. Waste and warning pipes may, however, be of less weight, but not less than is given in Table II.

TABLE I

WEIGHT OF LEAD PIPES

Diameter Inches	Weight Per Yard Pounds
$\frac{1}{2}$	6
$\frac{5}{8}$	$7\frac{1}{2}$
$\frac{3}{4}$	9
1	12
$1\frac{1}{4}$	16

WATER SUPPLY

212. Cistern.—The contractor shall provide and fix in the roof over the bath-room a 300-gallon galvanized-iron cold-water tank with all necessary perforations for the various connections. This cistern is to be raised on 9″ × 2″ bearers and is not to rest on the floor boards. Under cistern a 5-pound lead tray that projects 3 inches on all sides beyond the sides of tank, and has the lead dressed over a raised fillet and copper-nailed, shall be formed. An outlet from this tray shall be wiped to lead pipe, which shall be carried through the roof or wall and fitted with a hinged copper flap at its end.

TABLE II

WEIGHT OF WASTE PIPES

Diameter Inch	Weight Per Yard Pounds
$\frac{1}{2}$	4
$\frac{3}{4}$	$5\frac{1}{2}$
1	6

213. Supply From Main.—The contractor shall dig up the ground in the road and shall connect to the company's main, or pay the water company to make the connection, with a $\frac{1}{2}$-inch screw ferrule and stop-cock, and shall carry on to the building with a lead pipe laid at least 2 feet below the ground level and encased in a rough deal tarred box filled with pitch. He shall fix on this supply, in a convenient position in the basement, a brass screw-down full-way stop-cock, and next to it, on the house side, he shall wipe on to the main pipe a small branch with the draw-off cock to empty the system, if necessary. The rising main

shall be carried to the cistern with a $\frac{3}{4}$-inch lead pipe and finished with a high-pressure equilibrium ball valve. From the rising main shall be laid a $\frac{1}{2}$-inch branch to supply the tap over the scullery sink.

214. Cold-Water Service.—The contractor shall tap the cistern 2 inches above its bottom and connect a $1\frac{1}{2}$-inch brass screw union fly-nut and washer. This shall be wiped to a $1\frac{1}{2}$-inch lead pipe, which shall be carried down to supply the various draw-offs. From this delivery pipe he shall lay a $\frac{3}{4}$-inch supply to the w.c. on the first floor, a $\frac{3}{4}$-inch supply to the bath, and a $\frac{3}{4}$-inch supply to the hot-water tank. This should be connected to the bottom of the tank with a dip to prevent the hot water from backing up. Below this level the delivery pipe is to be 1 inch, and $\frac{3}{4}$-inch branches are taken to the w.c. on the ground floor and servants' w.c., to the sink, copper, and pantry sink, and to the furnace room, and a $\frac{1}{2}$-inch branch to lavatory basin.

215. Overflow.—Near the top of the cistern is to be connected a 1-inch brass screw union fly-nut and washer to which is wiped a lead overflow pipe. This pipe is to be connected to the waste from the tray under the cistern, which is to be carried outside of the building as already specified. A 1-inch pipe with union, etc., as before, is to be connected to the bottom of the cistern; it is to terminate in a convenient position with draw-off cock for emptying the tank when cleaning is necessary.

216. Bib-Cocks.—The water-supply branches to scullery sink, copper, and pantry sink are to terminate with $\frac{3}{4}$-inch screw-down gunmetal bib-valves.

217. Bath and Lavatory Basin.—The contractor shall allow the p.c. sum of £10 for bath and lavatory basin, which is to be selected by the architect; this sum is to include hot- and cold-water valves and the making of all necessary connections and fixings for same. A $1\frac{1}{2}$-inch trapped lead waste is to be connected to the waste outlet of the lavatory basin and each sink. This waste must have a brass screw connection and cleaning plug to the trap, and is to be carried through the wall and discharge over gully. The scullery sink is to have a perforated brass grid over the waste. In a similar manner a 2-inch lead waste is to be connected to the cast-iron trap of the bath and carried through the wall and connected to the cast-iron drain pipe to discharge over the gully.

218. W.C. Apparatus.—The p.c. sum of £4 shall be provided for each w.c. apparatus in the house; this sum is to include mahogany seat, glazed earthenware pan and trap, 2-gallon water-waste preventer, and chain. The p.c. sum of £2 shall be provided for similar apparatus to the servants' w.c., complete; these fittings are to be selected by the architect. The contractor shall provide and fix a $1\frac{1}{2}$-inch heavy lead flushing pipe; this is to be fixed to the wall in the house closets with brass clips and in the servants' closet with lead tacks.

219. Lead Trays.—Under the bath and the apparatus in both w.c.'s, a 4-pound lead tray is to be formed. This must be properly dressed over the fillet at the edge and close copper-nailed; it must also be dressed against the skirting 3 inches high and close copper-nailed. A $1\frac{1}{2}$-inch lead waste is to be connected to this tray and carried through the wall; it is to be finished with a brass flap.

220. Pantry Sinks.—The pantry sink is to be lined with 5-pound lead, which will have wide soldered joints at the angles, will be turned over the top edge of the sink, and close copper-nailed. The lead is to be properly dressed to the bottom of the sink and wiped to a brass outlet, which is to be provided with a plug and chain.

221. Hot-Water Supply.—All hot-water pipes are to be galvanized wrought-iron welded steam tubing, with all tees, angles, unions, reducing sockets, etc., that may be necessary. All joints are to be screwed in red-lead cement, and the pipes are to be secured by wrought-iron clips. The pipes are to be fixed in all cases at least 2 feet from all cold-water pipes. The outgo of the range boiler is to be connected by a $1\frac{1}{2}$-inch flow-and-return pipe to a 50-gallon galvanized-iron hot-water tank with a handhole. The tank is to be fixed in the linen cupboard, resting on rough bearers on the floor. From this flow pipe, $\frac{3}{4}$-inch separate supplies are to be branched off to the bath and the lavatory basin, and to each sink. The branches over the sinks are to be finished with $\frac{3}{4}$-inch gunmetal screw-down valves.

GAS-FITTER

222. Piping.—All gas pipes are to be wrought-iron welded tubing and have all necessary tees, angles, crosses, nipples, stopped ends, and other connections; the joints are to be screwed in red lead. Piping is to be fixed to the walls with hooks and to the woodwork with iron bands; it must be fixed with a fall toward the meter wherever possible. Where this is not possible, a small drip pipe and cock must be placed at every lowest point to draw off any liquid that may accumulate. All pipes, as far as possible, are to be so placed as to be accessible for repair without unduly disturbing other work.

223. Size.—All pipes and branches are to be of ample size to supply gas to all the fittings connected to them; no branch is to be less than $\frac{1}{4}$ inch in diameter.

224. Cutting.—The contractor shall cut all holes and chases necessary in other work and make good afterwards.

225. Testing.—Before any of the gas piping is covered, the whole system shall be tested, to the satisfaction of the architect, to a pressure equal to 5 times that existing in the company's mains.

226. Connections to Main.—The contractor shall open up the ground in the road and connect to the gas company's mains with a $1\frac{1}{2}$-inch screw ferrule. He shall take to the building a $1\frac{1}{2}$-inch piping, which is to be buried 2 feet below the surface of the ground and packed in a rough deal tarred trough filled with pitch. On this pipe shall be fixed a $1\frac{1}{2}$-inch full-way brass stop-cock and key, which shall be enclosed in a cast-iron box bedded in concrete.

227. Meter.—The contractor shall allow for the hire of an 80-light dry meter, which he shall fix behind the wine-cellar door in the basement on a $1\frac{1}{4}$-inch wrought deal shelf, with brackets.

228. Distributing Pipes.—The outgo of the meter shall be connected with a heavy lead pipe and brass connection, and shall be fitted with a $1\frac{1}{2}$-inch brass stop-cock and key. All distributing pipes for supplying the ground-floor brackets and basement fittings are to be hung to the under side of the ground-floor joists; other horizontal distributing pipes are to be fixed under the floor boards between the joists, where possible. If they must be laid transversely to the lengths of the joists, no joist shall be cut for a gas pipe more than 2 feet from its support.

229. Distribution of Pipes.—A $1\frac{1}{2}$-inch riser shall be carried up from meter outlet to the top floor; and from this pipe, at the level of the under side of the ground-floor joists, there shall be taken one 1-inch pipe to supply the brackets in the drawing- and morning-rooms, and all the fittings in the back addition, the basement, and the staircase. This pipe is to be diminished to $\frac{3}{4}$ inch to the back additions and only a $\frac{5}{8}$-inch run to the brackets in the servants' w.c. and over the sink. From this pipe a $\frac{3}{8}$-inch riser is to be carried up to supply the two brackets on the half landing of the stairs. At the same level, a 1-inch pipe is to be taken to supply the brackets in the vestibule, dining-room, and pantry. At the level of the first floor, a 1-inch pipe is to be taken to supply the brackets in bedrooms *1* and *2* and the dressing-room, also the pendants in the hall and morning-room. Another 1-inch pipe from the riser is to supply the brackets in bedrooms *3* and *4*, the bathroom, w.c., and landing, and the pendants in the dining-room and kitchen. At the top-floor level, a $\frac{3}{4}$-inch pipe is to be taken for the brackets in bedrooms *5* and *6* and the landing and the pendants in bedrooms *1* and *2*; there will also be taken off a $\frac{3}{4}$-inch pipe to supply the brackets in the box room and bedroom *7* and the pendants in bedrooms *3* and *4*. Minor branches are to be $\frac{1}{4}$-inch pipe for single-light fittings, $\frac{3}{8}$-inch for two-light fittings, $\frac{1}{2}$-inch for pendants, and $\frac{5}{8}$-inch to all other branches except the main lines already specified.

230. Fittings.—The contractor shall provide the p.c. sum of £30 for gas-fittings, to be selected by the architect. He shall perform all necessary fixing, with rough blocks to hang the pendants from the joists. All brackets, unless otherwise ordered, are to be fixed 7 feet above the floor.

PLASTERER

231. Laths.—The laths are to be riven fir laths of the thickness known as lath-and-half; they are to be nailed with 1-inch galvanized nails, and shall break joint in 2-foot widths.

232. Lime.—The lime is to be freshly burnt grey-stone lime from an approved firm. It must be slaked on the site, screened, and run into putty at least 2 months before it is required for use.

233. Sand.—All sand must be clean sharp freshwater or pit sand; it must be free from any loamy or organic matter and well screened.

234. Coarse Stuff.—All coarse stuff for plastering is to be composed of 2 parts of sand to 1 part of lime, and must have 1 pound of long clean bullock's hair, free from grease well mixed up in each 3 cubic feet of mortar.

235. Wire Lathing.—Stout wire lathing of an approved kind must be used to cover all chases over pipes and for bending round the angles at the junction of ceilings and walls, where necessary.

236. Plaster on Walls.—The contractor shall render, float, and set all walls where not otherwise described. Walls above picture rail in dining-room are to be finished in Keene's cement and have a coat of white paint applied as soon as the plaster is laid and before it becomes dry.

237. Plaster Ceilings.—The contractor shall lath, plaster, float, and set all ceilings, stud partitions, and soffits of stairs, excepting the basement.

238. Angles.—All angles shall be run in Keene's cement on a Portland-cement backing; all salient angles are to be rounded slightly.

239. Cornices.—All cornices are to be run cleanly and accurately in plaster and putty on a rough-plaster backing, according to the sections supplied by the architect, and all necessary mitres, stops, and returned ends formed. A plaster cornice of 12-inch girth, with $1\frac{3}{4}$-inch enrichment, shall be run round the dining-room. A cornice of 12-inch girth, with dentils, shall be run round the drawing-room, and one of 15-inch girth, with modillions, round the hall. A cornice of 9-inch girth shall be run round the vestibule, morning-room, and all first-floor bedrooms, the dressing-room, and the landing; and a small moulding of 4-inch girth shall be run round the bathroom and w.c.

240. Paving.—A $\frac{3}{4}$-inch neat cement paving on concrete shall be laid in the larder, coal cellar, and servants' w.c., and in part of kitchen, as shown. A similar paving shall be laid in the basement, except furnace room, and bottom of basement area; it is to be turned up 6 inches against the wall and have rounded angles.

241. Hearths.—The contractor shall set all tile hearths, the cost of which is included in the provisional sum already allowed for stoves and range.

242. Rough Cast.—The spaces between the wooden uprights in the gables shall be lathed and plastered with cement and finished with rough cast.

243. Making Good.—The contractor shall make good in plaster of Paris wherever necessary to all shelves and other places disturbed for fixings in other trades.

244. Limewhite.—The walls and ceilings of the larder, coal cellar, servants' w.c., and throughout basement shall be given two coats of lime-white.

245. Distemper.—All ceilings, soffits, cornices, and friezes of all walls having a picture rail, except in the dining-room and hall, shall be given two coats of white distemper. The walls of the kitchen, scullery, and pantry shall be given two coats of distemper of an approved tint.

GLAZIER AND PAINTER

246. General Conditions.—All glass is to be the best of the kind specified and free from bubbles, scratches, and other defects. It must be properly set in putty, and back puttied and sprigged where necessary. All glass in doors must be set in wash leather and fixed with movable beads.

247. Plate Glass.—The windows in the dining-, drawing-, and morning-rooms, the vestibule screen, and the four bedrooms on the first floor are to be glazed with $\frac{1}{4}$-inch British polished plate glass.

248. Figured Glass.—The glazed doors and lavatory window are to have figured rolled white glass of an approved pattern.

249. Sheet Glass.—All glass, except that otherwise specified, is to be 21-ounce sheet glass.

250. Paint.—All paint materials are to be pure and the best of their respective kinds. The oil is to be the best linseed; and for white paint, zinc and not lead paint is to be used. All varnish is to be the best copal.

251. Painting Interior Work.—The contractor shall knot, stop, prime, and paint all interior wood, and other work usually painted, with four coats of good oil colour. The dining-, drawing-, and morning-rooms and the hall are to have the last two coats in a good enamel paint. The dining-room and hall paint is to be finished flat. The four coats are to be

in all cases in addition to the priming, and all painted work is to be rubbed down with fine glasspaper between the coats.

252. Painting Exterior Work.—The contractor shall knot, stop, prime, and paint with four coats of good oil colour, and finish in white, all external woodwork, except doors and any work in hardwood. The external surfaces of all doors, except main-entrance doors, are to be finished in green, the tint to be selected by the architect.

253. Painting Exterior Ironwork.—All ironwork, whether exposed or not, is to have two coats of antioxide paint before fixing, and all exposed ironwork is to have four coats of good oil colour afterwards. All gutters are to be finished white, and rain-water heads and down pipes are to be finished a lead colour.

254. Polishing.—The contractor shall prepare and properly french polish the mahogany hand rail to stairs.

255. Blacking Stoves and Range.—The contractor shall clean all stoves and leave bright parts polished ; the black parts are to have two coats of best Berlin black.

256. Stencil Work.—The sum of £10 shall be allowed for stencil friezes in the dining-room and hall ; to be executed as directed.

PAPERHANGER

257. General Conditions.—The contractor shall prepare, rub down, stop, and size all walls that are to be papered. All papers must be cut on both edges and hung with butt joints with pattern truly formed, except on top floor, where papers may be lapped.

258. Papers.—The contractor shall provide and hang in dining- and drawing-rooms paper having a list price of 4s., and in morning-room, paper having a list price of 3s. 6d. For the staircase and landings, the paper is to have a list price of 3s., and in the first-floor bedrooms a list price of 2s. 6d. The top-floor bedrooms are to have paper that has a list price of 1s. The paper in the lavatory, bathroom, w.c., and linen cupboard is to have a list price of 2s. and be twice sized and varnished. All papers are to be selected by the architect from the stock of an approved manufacturer.

GENERAL REQUIREMENTS

259. The contractor shall clean all windows, scrub all floors, black, as necessary, all stoves and ranges, oil all locks, and make good any defects or damage that may arise during the progress of the works, and leave all clean, perfect, and tidy at completion and to the architect's entire satisfaction.

ALTERNATIVE CLAUSES

260. Insurance.—In cases where the work consists of alterations to an existing building, the following clause would be substituted for the one given :

The whole building and the works executed under this contract shall be at the sole risk of the employer as regards any loss or damage by fire, and in the event of any such loss or damage being so occasioned which will affect the original building or structure in addition to the new work, the contractor shall be entitled to receive from the employer the full value of all work then executed and materials then delivered. This value shall be calculated by measuring and valuing them upon the prices contained in the original contract, or, where the same may not apply, at rates proportionate to the prices therein contained.

261. Flats.—In the case of large flats covered with lead, joints are necessary ; these are formed by means of rolls in a direction parallel to the fall and drips in directions across the fall. In this case the specification should read :

The flats are to be covered with 7-pound lead properly dressed over all rolls ; the undercloak is to go three-quarters round the roll and be close copper-nailed. The overcloak must be dressed completely over the roll and lie $1\frac{1}{2}$ inches on the flat. Drips are to be formed not more than 10 feet apart and must be 2 inches deep ; the undercloak must be closely dressed into a rabbet at the top of the drip and copper-nailed, and the overcloak dressed over the vertical face of the drip to within $\frac{1}{4}$ inch of the horizontal surface of the undercloak. Where the flat abuts against a brick wall, the lead must be turned up 6 inches and covered by a 5-pound lead cover flashing. Lead gutters are to be formed similarly with drips at least every 10 feet, and the lead at the side turned up 6 inches against the wall with a cover flashing. The cesspool outlet for the gutter should be formed at least 9 inches square ; it is to be lined with 7-pound lead properly bossed round the cesspool, all joints being formed at the angles and covered by a wide solder joint. The lead is to be dressed properly to the outlet and wiped to the end of a 4-inch outgo pipe.

Zinc flats are to be laid without nailing of any kind, and the rolls are to be of a square or trapezoidal form. The sheets must be of No. 14 gauge. Copper roofs are laid with welded joints instead of rolls.

262. Plumbing.—Where the water supply company's regulations control the weights and sizes of pipes to be used, their demands must be complied with.

263. Slater.—If the roof is to be slated, $2\frac{1}{2}'' \times \frac{3}{4}''$ battens will be used ; their spacing will depend on the size of the slates used. In some of the best quality slating, the slates vary in size ; these are laid in diminishing courses, with the smaller slates at the top of the roof. If slating of this kind is required, the specification clause should be about as follows :

The roofs shall be covered with best green Westmoreland slates laid in diminishing courses and nailed with galvanized, or copper, nails near the head. Ridges and hips to be formed with blue tiles, lead roll, or with a slate roll and wings ; valleys are to be mitred and have a secret gutter.

If a cheaper form of slate roof is required, Bangor, countess or duchess slating should be specified. Battens for countess slating should be spaced $8\frac{1}{2}$ inches apart from centre to centre, and for duchess slating $10\frac{1}{2}$ inches apart for a 3-inch lap.

264. Electric Lighting and Bells.—Electric lighting, if it is to be installed, might be treated as a subcontract and an estimate for the work obtained from a reliable firm. The amount of this estimate should be included in the specification as a p.c. amount, and a clause inserted that the contractor is to provide all facilities to the subcontractors, cut away for them as necessary, and make good after them. If it is desired to have electric light, but not as a subcontract, the gas-fitter part of the specification should be omitted or considerably reduced, and a specification of electric lighting work included.

SPECIFICATION OF DILAPIDATIONS

USES AND CHARACTERISTICS

265. Definition.—A specification, or schedule, of dilapidations is, strictly speaking, a notice of breach of covenant ; but, as a matter of fact, a schedule of dilapidations is nearly always drawn up by the landlord's surveyor at the termination of a repairing lease, so that the document is treated rather as a basis on which to arrange a settlement than as a complaint of default. When a person enters into an agreement with a property owner, or with a property holder, by which that person is to enjoy occupation of a house or land on consideration of his paying the

owner a certain sum of money at fixed intervals, that person is said to be a **tenant,** or **lessee,** of the property he occupies. The property holder from whom he holds the land and to whom he pays the rent is known as the **landlord,** or **lessor,** and the agreement entered into between them is known as the **lease.** The terms of the lease define the rights and obligations of each party, and, as a rule, there is a clause to the effect that the tenant shall perform all necessary repairs, or possibly only repairs of a certain kind, and at the *termination of the lease,* that is, when the agreement ceases to have effect, the tenant shall deliver up the property in good repair.

266. When a lease of this kind is to be terminated, the landlord's surveyor carefully examines the property to see whether the tenant is leaving his holding or tenement in the condition called for by the terms of the lease. If the surveyor finds, as he usually does, that several matters need attention, and several parts of the structure need repair or reinstatement, he makes a complete and detailed statement of all work that he considers the tenant should do to comply with the terms of his lease. This detailed statement constitutes a specification or schedule of dilapidations, and a copy is served on the tenant with a demand that he shall forthwith perform all the works enumerated in the specification.

If the tenant considers that the demands are excessive, either he or his surveyor may object to the schedule, or parts of it, and possibly submit alternative proposals; both the landlord and tenant or their surveyors must then agree as to what will be acceptable to both; but if this is not possible, an arbitrator must decide the case. Of course, the matter should be settled without any unnecessary expense, such as surveyors' and arbitrator's fees; therefore, if both parties will accept a fair and equitable compromise, a settlement may be effected without much difficulty. In many cases, the arrangement arrived at is that the tenant shall pay the landlord a sum of money in lieu of carrying out the repairs.

267. The surveyor in preparing his specification should not be exorbitant in his demands, with a view to securing the utmost gain for his client, but should endeavour to draw up a fair statement

which will facilitate a just settlement. Strictly speaking, a schedule of dilapidations should mention only the deficiencies which need repair or renewal, and no suggestion should be made as to the ways and means to be adopted in righting the same. In theory, a schedule of dilapidations is a complaint that the lessee has not complied with the terms of his covenant to leave his holding in good repair; but in practice the schedule often takes the form of a specification of the necessary works of repair.

268. Variations in Leases.—Before preparing a schedule of dilapidations, the surveyor must see how the clauses of the lease are worded so that he may rightly understand to what extent the tenant is bound to repair and in what state he must leave the holding. Leases are variously worded in this respect, but the landlord cannot expect to get a building as good as new at the expiration of a lease, though it may happen that the tenant has to rebuild a place if it should be destroyed during the term of his lease. If the tenant is exempted from the obligation to remedy the effects of fair wear and tear, then his liabilities are reduced to a minimum, and the surveyor must do what he can to find out the original condition of the property and use his judgment as to what may fairly be required of the tenant. The question of the amount a tenant may be called on to do under the variously worded clauses that may be found in a lease cannot be definitely stated, but a surveyor having experience in the district will know quite well what is intended; but if there is particular difficulty in any case a solicitor may be consulted.

269. Arrangement of Schedule.—As to the arrangement of a schedule of dilapidations, probably the best form to adopt is to give a heading stating the designation and situation of the building and the names of the parties to the lease somewhat as follows:

Schedule of dilapidations found to exist at the private dwelling house, No. 8 Duffield Street, London, W., having regard to the covenants of the lease made between Mr. E. H. Smithson as lessor and Mr. E. P. Storey as lessee, expiring , 191–, by

S. G. Smith, Surveyor,
Adelphi Chambers,
Simonstown.

Then the matter of the schedule should be grouped under such headings as : Exterior work, interior work, general requirements, top floor, box room, front bedroom, back bedroom, landing, staircase top floor to second floor, second floor, front bedroom, etc. Each room, landing, staircase, etc., should be taken in an orderly manner, and the various defects to be remedied specified in detail.

270. Description of Work.—The description of exterior work should include clauses, as may be found necessary, dealing with such items as : Gates and fences, pavings, steps, exterior plaster work or pointing of building, painting to doors and windows, eaves gutters, down pipes, etc., and any repairs necessary to each, repair of lead or zinc flats, roof flashings, slates or tiles, and gutters, pointing to parapets and chimneys, renewal or repair of chimney pots or their flaunching ; and any other items necessary, including, possibly, repairs to drains and outbuildings. The general clauses dealing with interior work should mention that cisterns and boilers are to be cleaned and chimneys swept, and might even state that all ceilings are to be whitened or papered and walls repapered and woodwork repaired ; but the arrangement of items under general clauses or their being put under the various subheadings must be left to the discretion of the surveyor. By putting general clauses under a general heading a good deal of repetition may be avoided, but clearness and simplicity should be sought in the arrangement adopted. The clauses with respect to one bedroom may be as follows :

FIRST FLOOR

Large Back Bedroom.—Reinstate broken pane of glass in window, renew perished putties, reinstate defective sash fastener, and renew broken and frayed sash lines. Cut out and renew damaged portion of skirting under the window and paint four coats, finished to match other paint work. Renew broken firebrick backing of grate and reset loose hearth tiles. Properly cut out and stop open crack in door panel and replace missing moulding where necessary ; paint four coats to match other paint work. Oil and repair lock as necessary and replace missing key. Fix loose defective floor boards near hearth, replacing broken and decayed parts with new. Clean down and paint with two coats all woodwork, making up, as necessary, on worn or damaged parts with extra coats. Strip and repaper walls. Wash, stop, and whiten ceiling.

271. The last two clauses, and possibly some of the others, might be covered by the general clauses of the schedule, in which case they would not need repetition. The only difficulty in work of this kind is in determining exactly how much the tenant is bound to repair and amend. It may be found that a good many items mentioned here as coming into a schedule of dilapidations would in many cases be omitted entirely as being beyond the range of the tenant's obligations.

SPECIFICATION MEMORANDA

BUILDING ERECTION, CONSTRUCTION, AND EQUIPMENT

INTRODUCTION

1. The writing of specifications for building work in which are described all the necessary data pertaining to the erection, construction, and equipment of buildings is a very important matter, and one over which the architect should take the greatest care. Many architects keep beside them a classified list of headings for specifications, which they look through as they are writing the specification for any particular work, taking from it such headings as will apply to the particular case before them and omitting those for which there is no work to be done on the job. Such a list is of great assistance to a writer, as it enables him more readily to put the various clauses in their correct order and also reduces to a minimum the likelihood of any important clause being missed. Even with this list, the architect must carefully think for himself on each new specification, and must determine whether there is something that is not covered by the list of headings before him.

Every job must be considered entirely by itself and in such a manner that nothing in the way of work or materials necessary to complete the building in a thorough and satisfactory manner is omitted from the specification, for if such an omission is made the builder may claim that he has not allowed for such work in his estimate, and will therefore, if he has to carry it out, ask for an extra on his contract. The following memoranda are

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for the assistance of the writer of specifications, and will enable him to find, without delay, much necessary information stated in a brief and concise manner, but it must not be thought that every point likely to be encountered when writing a specification has been touched on, or that every heading likely to occur has been given.

GENERAL CONDITIONS

2. Importance of Clauses.—The general conditions at the commencement of a specification are very important, for they contain many clauses that may affect a contractor's price for the work; they should therefore be carefully thought out in order that trouble may be avoided later on. Many of the clauses, to a beginner, may seem obvious or unnecessary, but all work required for the completion of a building should be stated. The general conditions should always state whether or not the contractor is to insure the building against fire and provide an office for the clerk of works. They should also state that all materials and workmanship are to be the best of their respective kinds, and that the contractor is to provide water for the use of the works, and any protection and temporary lighting that may be necessary. The contractor must be made responsible for setting out the works from the drawings, and should amend at his own cost any mistakes due to incorrect setting out. He should also make good at his own cost any damage done through the works to persons, property, or things.

3. The contractor in the ordinary course would keep a competent foreman on the works, but the specification should state that he is to do this. He should also be made to provide proper latrines and sheds for the workmen and materials, all of which must be cleared away on completion. If any hoardings or gantries are necessary, they should be specified, and the contractor should be responsible for giving all notices to local authorities, gas, water, electric-lighting, or other companies, and should pay all fees legally demandable. He should also, at his own cost, divert all drains, mains, conduits, etc., found on the site, and should clean up the whole of the premises and site and remove all rubbish on completion.

4. Form of Contract.—In the majority of specifications, the first clause contains a list of the drawings on which the contract is to be based, then follows a statement giving particulars of the form of *contract* to be used. It is customary in all cases for the builder and employer to sign a contract for the carrying out of the work; this is a legal document and is sometimes drawn up by the employer's solicitor, but more often it is based on a printed form published by the Royal Institute of British Architects, and known as the *R.I.B.A. contract.* The kind of contract form

to be used should be mentioned in the specification, so that the builder may be fully aware of the whole of the conditions of the work to be done.

5. Payment, Etc.—The date of the commencement and completion of the works must be given in the general conditions, and the mode of payment. If the R.I.B.A. form of contract is to be adopted, the method of payment is included in that, but it is well to repeat it in the specification. Payment is generally made by the architect certifying at intervals that a certain sum is due to the contractor. It is usual to make the contractor responsible for defects that may appear in the work, due to improper material or bad workmanship, for a period of 3, 6, or 12 months after the completion of the work, according to its size. Local conditions may require that certain other clauses be put in the general conditions. In *Specifications*, a typical set of conditions has been given, but these will not be applicable to every case. Each specification must be written with special reference to the work to which it refers, and clauses must be altered, omitted, or inserted to suit the particular requirements of each case.

EXCAVATOR AND CONCRETOR

EXCAVATOR

6. Levels. — When preparing a site for the erection of a building, the elevation of the structure above some imaginary reference level, called the *datum line*, or simply the *datum*, must be predetermined. The formal datum line in the British Isles is taken as the mean level of the sea at Liverpool. In setting out the plans of a building, the ground-floor level is usually determined above this datum, or above some other easily determined datum level on the site.

7. Depth of Excavations. — Cellars for dwelling houses should have a depth of at least 8 feet from the under side of the ground-floor joists to the cellar floor, and a greater depth should be provided where the house is to be heated by means of a hot-water circulating system, in order to give sufficient height above the boiler to allow a proper gradient for the pipes. For shops, offices, and manufacturing buildings, the depth is greater, varying according to the nature of the business carried on, or the requirements of the occupants.

8. Depth of Footings.—The depths of footings should be regulated by the nature of the soil and the depth to which the frost penetrates in the locality, and should be shown on the drawings. Where possible, the depths necessary to give a good foundation should be ascertained by digging trial pits. The contractor should go deeper if the soil proves unsafe to build on at the depth specified, and the specification should

so provide. The contractor will, of course, receive extra payment for such work, and should notify the architect or clerk of works when such an occasion arises, in order that a record may be kept of the extra amount of excavation that is done. All surplus excavation should be removed or deposited as directed.

9. Width of Trenches.—The width of trenches, etc., for walls should be from 8 to 12 inches wider than the actual dimensions of the footings, walls, or piers, in order to allow of proper inspection and so that the outer side of the wall may be properly pointed as it is built. The widths of trenches are usually governed by the widths of the footings, which are proportioned according to the weight they are to carry and the thickness of the wall over them.

10. Bad Ground.—Bad ground is often found in patches on a site. The specification should clearly state that, if such is found, the contractor must call the attention of the architect or the clerk of works to the same before putting any concrete in the trenches. The architect will then determine what is to be done with same, whether the trench is to be dug deeper until a sound foundation is found, or whether the difficulty is to be got over by means of piles, or in any other way.

11. Subsidence.—A very careful clause should be inserted under the heading subsidence. Very often the subsidence of a building is due to work done or material used by the contractor; if it can be proved that this is the case, the contractor should be made entirely responsible for the remedy of the defect. But if the subsidence has been caused by any reason beyond the control of the contractor, the cost of remedying the defect should be allowed to him. No concreting should be done to trenches or over the site until the architect, or a representative appointed by him, has inspected the trenches and certified that the concreting may be commenced.

12. Excavation in Rock.—Excavations are assumed to be in ordinary soil or clay; provision should therefore be made for obtaining rates over and above ordinary excavations: First, for blasting or removing boulders of 10 to 20 cubic feet; second, for loose rock or shale; third, for solid rock. It is more expensive to excavate rock, etc., in wall or drain trenches than over a large area, such as for a cellar or heating chamber. Provision should be made accordingly under separate headings. Where rock must be taken out so close to existing walls that injury will result from blasting, the operation of wedging is resorted to, and a carefully worded clause must be inserted stating clearly how this is to be done.

13. Shoring, Strutting, Etc.—When the foundations of a building, whether new work or an alteration, extend below the foundations of adjoining property, shoring, needling, underpinning, and bracing must be

resorted to, in order to protect the walls of the existing structure. Openings in the walls which are affected by shoring operations must be securely strutted. When adjoining buildings have been built originally with party walls, or walls supporting the floorbeams of two buildings, and one of these buildings is to be pulled down, the adjacent walls should be guarded against falling by raking or flying shores. When there are buildings on each side of the site on which the new building is to be erected, the walls of these structures may be supported by horizontal or flying shores. In any case, the contractor must be made responsible for the safety of adjoining buildings when carrying out his contract.

14. Sheet Piling.—Sheet piling, or planking and strutting, is used in soft and treacherous soils to keep the trenches open during the building of the walls. These piles, which are flat pieces of either wood or steel, are driven side by side against the bank of the excavation, forming a continuous partition to prevent the spread of the soil. Wooden sheet piles are either jointed by butting or are matched. Steel piles are of different forms with or without caulked joints. In all cases the contractor should provide all planking and strutting necessary.

15. Hoardings and Fans.—In many town and city buildings, especially where they are being erected on public thoroughfares without a forecourt, hoardings must be erected to prevent people walking into the building, and fans must be built to keep materials, etc., from falling on the public passing in the street. The contractor should in all cases be responsible for the erection, maintenance, and clearing away of all hoardings and fans, and also for giving any notices necessary to local or other authorities previous to erecting them, and for paying any fees legally demandable.

16. Water in Excavations. — If water is encountered in any quantity, provision should be made to lead it away from the walls by means of stoneware or fireclay drains. This is very important, and the strength of the foundations is often greatly dependent on this precaution. On the other hand, water is often necessary for the stability of the soil, as, for example, a saturated sand bed, and it would be disastrous to drain it. Provision should also be made for pumping or otherwise removing the water, which may accumulate in the excavations, during the progress of the works.

17. Foundation Beds. — When rock suitable to build on is encountered, it should be stepped in level beds where necessary to receive the walls, and all hollow spots should be filled with concrete. Sand forms a good foundation bed if kept dry, and if confined laterally, a wet sand bed is safe for building on. Clay, when hard and dry, is usually a good bed, but if damp and on a slope, it is treacherous unless it is confined, as it is liable to slide. Gravel forms a good foundation bed, is easily levelled, and, if

reasonably dry, has a large bearing power. Made ground should never be trusted to carry any great weight, and, if it is possible, the excavation should be carried through this to a firmer bed ; but, if this is not possible, the walls should be carried on thick concrete foundations that are so spread as to widely distribute the weight.

Foundations should be so constructed that the pressure on the soil under them will be well within the safe bearing power of the soil at all points ; or, if this is impossible, so that the settlement will be uniform at all points. Great care should be bestowed on the examination of the bottoms of the trenches, in order that soft spots, etc., may be removed and the holes filled with concrete. If a very large spot should occur in an otherwise good foundation, it should be spanned with a concrete lintel or a brick arch springing from the abutting footings. The bottoms of trenches should be well rammed before any concrete is laid on them.

CONCRETOR

18. Lime.—The lime used for foundation work in some situations is generally either greystone or blue lias. Lime is cheaper than Portland cement, and, on that account, is used instead of cement, though for all situations it is not so satisfactory. Commercially, it may be divided into *rich*, *fat*, or *pure lime*, *poor lime*, and *hydraulic lime* ; these vary from one another in the amount of clay, sand, or iron they contain. Care should be taken in specifying lime that the source from which it is to be obtained should be given, or else the standard of quality to which it is to attain.

19. Fat lime, or lime with not more than 5 or 6 per cent. of impurities, should not be used where any moisture is encountered. It should be used for work above the finished ground line, plastering, or for whitewash. Good ordinary lime should have from 10 to 30 per cent. of impurities, such as silica, alumina, etc. Hydraulic lime, or lime containing from 5 to 30 per cent. of impurities, should be used for work below ground level or in damp spots.

20. Lime Grinding.—The lime should be ground just before slaking, as grinding ensures a more thorough slaking and is less likely to leave unslaked lumps that are liable to cause trouble after being built into the wall, where the slaking process continues. Portable mills for grinding mortar are largely used. These are a combined engine and mill on wheels, and where used minimize the danger of refractory lumps of lime in the mortar. Lime should be slaked by itself before being mixed with any other material, and allowed to stand for at least 1 week before using. The resultant *lime putty* should be free from unslaked particles.

21. Cements.—Cements may be divided into two classes: *natural* and *artificial*. Of the natural cements, Roman cement is quick setting,

and is therefore useful in tide work and similar positions. It deteriorates by exposure to air and age, and should be mixed only in small quantities, as it sets very quickly after mixing. It is very often specified for foundation work in damp situations. The artificial cement known as Portland, when good, is of a blue-grey colour. Fineness and weight indicate good quality, the weight varying from 108 to 120 pounds per bushel. The slowest-setting cement usually attains the greatest strength. Quick-setting cement is rather brownish in colour and often turns weak, owing to the too large proportion of clay in its composition. A standard specification has been issued by the Engineering Standards Committee, which gives most of the tests required for a good cement. The contractor should be required to have tests made of samples of cement he is using, as required by the architect, so that the architect may know that he is using the material specified. Cements are usually tested for their setting and hardening qualities, strength under tension, and compression at different ages, and also for the relation of these qualities to specific gravity and fineness. British cements are usually better than either German or Belgian.

22. Aggregates for Concrete. — The aggregate should be the hardest available, such as gravel, shingle, ballast, broken stone, furnace clinker, coke breeze, or broken hard bricks. For general purposes it should pass through a $2\frac{1}{2}$-inch ring; but for special purposes through a $1\frac{1}{2}$-inch or even a $\frac{3}{4}$-inch ring. When broken brick is used, care should be taken that the material is free from old mortar or plaster. Gravel, being rounded and smooth, does not adhere to the matrix so well as a sharper material. For ordinary work, the proportions of the various ingredients, by volume, should be: 1 part of Portland cement, 3 parts of sand, and 6 parts of aggregate. For important work, where great strength is required, a proportion of 1 part of Portland cement, 2 parts of sand, and 4 parts of approved aggregate is advisable.

23. Method of Laying Concrete.—Concrete should not be thrown to its final position from a height. It should be carefully lowered, or tipped out of barrows, and then spread out and settled, by ramming, which should be continued until the concrete is thoroughly consolidated, and the cement begins to appear on the surface. The surface of each layer should be left rough for the succeeding layer, which is applied in the same way, until the required thickness is obtained. In order to ensure that the concrete shall be a homogeneous mass, it is necessary to deposit a fresh layer before the previous one has become set, otherwise cracks are liable to develop in the finished work at the points where the layers join.

24. Ramming Concrete. — Concrete should be well rammed immediately after being placed in position, whether used for floors of buildings or for foundations. The compression thus obtained ensures

greater density and strength. This ramming, however, should not be too prolonged, or it will affect the strength of the concrete.

25. Precautions for Using Cement Concrete.—Cement concrete should be used as soon as mixed, and in hot weather it should be sprinkled lightly from time to time, just enough to keep the surface wet. This will retard the shrinkage somewhat and prevent surface cracks. In erecting a large group of buildings, or where the architect only visits the building a certain number of times each week, a clause should be inserted in the specification to the effect that the contractor shall give 24 hours' notice to the architect previous to beginning to lay the concrete.

26. Concrete Foundations. — In most districts it is obligatory to use concrete for foundations under all walls, except in the case of certain subfoundations. The foundations must have a minimum projection of 4 inches beyond the lowest course of footings, and a minimum depth of 9 inches.

27. Drainage of Foundations.—To drain the foundations, a line of porous agricultural tile with butted joints is placed at the base of the foundations. This pipe or tile should be laid with a pitch of not less than $\frac{1}{4}$ inch to the foot. The trench is usually filled above the pipe, to within 1 foot of the finished ground line, with broken stone, brick, or similar material. Unless a large spring is to be drained, the line of pipe may safely be run to some convenient distance from the building and the water allowed to soak into the surrounding soil by means of a stone pit. If the soil is impervious or the amount of water is excessive, some outlet other than a stone pit should be provided.

28. Concrete Foundation Walls. — Concrete foundation walls should be built between matched or grooved-and-tongued board framing, strongly made, to prevent bulging under the weight of the concrete, and should be laid in courses of not less than 6 inches nor more than 12 inches at one time. The upper surface of each course should be left rough, to form a key for the succeeding course, and if allowed to set and dry before the upper layer is placed, it should be made wet, as already described. Concrete makes a much stronger wall than one of brick or stone of the same thickness. The surface may be appropriately moulded, plastered, or finished in rough cast. The inside surfaces of the boarding must be planed smooth and washed with some substance, such as whitewash, soft soap, or oil, to prevent the adhesion of the concrete to the timber.

29. Concrete-Floor Construction. — Concrete-floor construction consists of reinforced slabs of concrete placed between steel or concrete beams. The reinforcement is obtained by so placing steel of different shapes as to take up the tension and assist in resisting the shearing stresses of the mass. The selection of a type of concrete-floor construction is a rather difficult matter, as there are a great many good systems on the

market. The advantages of concrete-floor construction are lightness and relative cheapness. The floors weigh from 40 to 60 pounds per square foot. The points to watch in concrete-floor construction are the use of inferior cement, sand, broken material, etc., and the misplacement of the reinforcements. When properly constructed, a reliable concrete-floor system makes a strong light floor; and where broken-brick concrete is used, the floor should withstand any ordinary fire.

30. Thickness of Concrete Cellar Floors.—Concrete floors for areas or cellars should be not less than 6 inches in thickness, with a top coat of strong cement mortar trowelled to a smooth surface. This coat should be not less than 1 inch in thickness. The under coat should be green, or, if set, should be wetted before the top coat is applied, and should be kept moist while setting. Care must be taken that the soil on which the concrete is laid is solid, and it should be well rammed before any concrete is laid. If any doubt exists as to whether the soil will sink after the concrete has been laid and thus make cracks in the concrete, a portion of the soil for a depth of about 9 inches should be excavated and the space so formed should be filled with hard broken bricks or stone on which the concrete should be laid.

31. Openings in Concrete Floors: Chases in Walls.— After the floors are constructed, openings are often cut for pipes, etc. This is liable to weaken the floor and should be avoided if possible by taking special care to have all openings left when the floors are being built. But if additional openings are necessary afterwards, they should be no larger than is absolutely necessary and should be well boxed with iron. Care should also be taken to leave chases in walls for pipes, etc., and any bolts that may be necessary for fastening woodwork, etc., should be built into the concrete.

32. Dividing Concrete Floors Into Blocks.—Where there is no danger of water working up through the floor, it is well to lay the concrete in separate blocks with paper between the joints, so that these blocks will be entirely independent; this reduces the effects of shrinkage. Where the floor is not so divided, it is good practice to cut a deep joint subdividing the top coat only into blocks as stated. Natural and artificial cements should not be used for two adjacent coats, as they will not adhere to each other. The same cement should be used for all coats.

33. Pugging.—If any pugging between wooden joists is to be executed, it should be carefully specified and the composition of the concrete, the method of fixing it between joists, and the thickness and level at which it is to be fixed given. If any pugging is to be done to partitions, similar information must be given as for pugging to floors.

34. Concrete Fixing Bricks.—If the joinery is to be fixed to concrete fixing bricks, they should be specified under Concretor. They must

be of the same size as the bricks being used in the general walling, so as to properly bond in with them. They are usually made of coke-breeze concrete, as this gives a secure hold to the nails used in fixing the woodwork.

DRAINLAYER

35. Drain Pipes.—The pipes to be used for drainage work should be of stoneware or iron, and in either case the size should be given. If of stoneware, for the best work, they should be specified as salt-glazed stoneware tested pipes, perfectly straight, truly cylindrical, and perfectly smooth as to interior glaze. Sometimes pipes from a special manufacturer are specified; when this is done, care should be taken that each pipe is stamped with the manufacturer's name.

If cast-iron drain pipes are to be used, their weight and diameter should be given. The castings must be true in section, free from surface defects which will impede the flow, straight, and with good-fitting spigots and sockets.

36. Excavation for Drains.—The excavation for trenches to take the drains is similar to that necessary for foundations to walls, except that the bottom of the trench must be excavated to a fall the same as the gradient of the drain. The excavation necessary should be specified under drainlayer, and it should be clearly stated whether or not the surplus earth is to be carted away.

37. Laying Drains.—All drains must be laid truly straight in line and gradient, and each pipe should be carefully cleaned out on the inside as it is laid. If this is not done, particles of cement used in the making of the joint may be left in the pipe and obstruct the flow of sewage. The gradient of drains should be worked from manhole to manhole and not along each individual pipe. This ensures obtaining a true and uniform gradient. The drains must be given a uniform fall or gradient throughout their entire length, and must not for any part of their length run level. A common rule for the fall of a drain is that a 4-inch drain shall have a fall of at least 1 foot in a length of 40 feet, a 6-inch drain a fall of 1 in 60, a 9-inch drain a fall of 1 in 90, and so on in proportion to the size of the drain pipe.

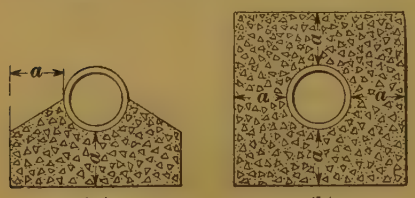

FIG. 1

38. Bedding of Pipes. When stoneware drains are used, and the soil is of gravel, hard sand, or other firm material, it is common in English provincial districts to bed the pipes directly on the soil. But it is desirable always to bed the pipes on a layer of

concrete, as shown in Fig. 1 (*a*); or, when the drains pass under the building, they should be specified to be thoroughly encased in concrete, as shown in Fig. 1 (*b*). In most cases where drains are encased in concrete, 6 inches of material is allowed all round them, as shown at *a* in Fig. 1 (*b*). Where they are only bedded on concrete, there should be a thickness of 6 inches under the pipe and the concrete should project 6 inches on each side of the pipe, as shown in Fig. 1 (*a*). No drains should be covered until they have been inspected, tested, and passed by the architect and the local sanitary inspector.

39. Drain Bends.—All bends, junctions, tapers, etc., should be specified to be similar, as regards manufacture and finish, to the drain pipes. No right-angled junctions or bends should be allowed, and all bends should be of easy curve.

40. Gullies. — The various gullies to be used should be carefully stated. There are three classes of gullies in general use: one form is used where a rain-water pipe discharges over a gully. Another form, having side inlets, is suitable only when the wastes or rain-water pipes are brought directly into the gully. The third form is used when the discharge from a sink contains considerable grease. This last form is often spoken of as a grease trap, and its form and make should be stated in the specification. The benching up round gullies should be carefully given; this is usually done in brick on edge set in cement and rendered over to the face of the top of the gully in cement.

41. Intercepting Trap.—The intercepting trap placed in the last manhole before the outfall to the sewer should have a good and deep seal, and should be of such pattern that it may be easily cleaned out if it gets choked. Often these traps are specified to be obtained from a special manufacturer.

42. Manholes. — Although manholes are built by the bricklayer, their construction is usually specified under Drainlayer. They are constructed for ordinary domestic work with sides of 9-inch brickwork and with a 6-inch concrete bottom, on which the necessary channels and bends are to be bedded. The channels at bottoms of manholes should be, for the best work, half or three-quarter round glazed channels of the radius required for the position in which they are to be placed. If the walls of the manhole, inside, are to be rendered in cement, as is done in the best work, it should be so stated in the specification. The tops of manhole walls are usually corbelled over to take the manhole cover; the size and description of the cover must also be given. Manhole covers can be obtained with single, double, and triple seal; for most work, double-seal covers are sufficient.

43. Cutting Into Manholes.—It is important to mention in the specification that all cutting for drain pipes in sides of manholes and

making good to same must be executed. Besides the holes for drain pipes, the one necessary for the fresh-air inlet pipe must not be forgotten.

44. Connection to Sewer.—The contractor usually has to give notice to the local authorities before opening up a roadway and connecting his house drain to a sewer. Besides the ordinary excavation necessary to such an operation, he will have to provide a watchman during such time as the public thoroughfare is opened up, and will also have to provide lights at night to show the extent of the excavation that has been carried out.

BRICKLAYER

MORTAR

45. Building Sand. — Good sand must be sharp; that is, each grain should be angular in shape and free from clay or loam. Sea and tidal-river sand should never be used, except in concrete for foundations, as the salt will crystallize on the wall, etc. Sea and river sand is usually sharper than bank sand. The British standard specification for sand used in testing cements is that it shall pass through a sieve of 20 by 20 meshes per square inch, and be retained on a sieve of 30 by 30 meshes per square inch, the wires of the sieve being ·0164 and ·0108 inch in diameter, respectively.

To test the amount of loam in sand, place a handful in a quart glass jar and then fill the jar with water. Stir this mixture well. After the sand has settled to the bottom, pour the muddied water above it into a second jar and allow this to settle for a few hours. If the sediment on the bottom of the second jar is of appreciable thickness, the sand should be rejected or else washed clear of loam before using.

46. Water. — The water should be fresh and clean and free from mud and vegetable matter. Salt water should not be used if it can be avoided, as it retards the setting. The quantity of water should be just sufficient to produce a plastic consistency suitable for the work for which the mortar is intended. The consistency of mortar for brickwork and masonry should be such that it will stand in a pile and not be fluid enough to flow.

47. Plaster of Paris is calcined gypsum. It is sometimes used for the setting coat in plastering, where its great shrinkage is regulated by the addition of sand. It is also used for making what is called *composition ornament*, such as capitals, brackets, mouldings, etc.

48. Proportions for Mortars. — Proportions for lime mortar and cement mortar vary somewhat, but good practice calls for 1 to 3 for

lime mortar, and 1 to 3 for Portland-cement mortar. The bearing power of brickwork laid in the different mortars may be obtained from almost any reliable handbook. Not more mortar should be mixed than is sufficient for 1 day's use.

49. Mortar Mixing.—Mortar should be mixed in special water-tight boxes, which should be kept as clean as possible. This ensures the exclusion of earthy matter. Mortar should never be mixed on the ground.

50. Waterproof Mortar. — To make a waterproof mortar, mix about 1 per cent., by weight, of powdered alum with dry sand and cement, and thoroughly dissolve about 1 per cent. of soft soap or any potash soap in the water that is to be used for mixing. When the mortar is mixed, the alum and the potash form a compound that is insoluble in water and makes the mortar non-absorbent.

WALLS

51. Technical Names of Bricks. — There are such a number of bricks of different kinds on the market, each sort having its own particular name, that it would be impossible to give a description of each. Each brickmaker has his own particular make of brick, so that when specifying bricks great care should be taken that the description is correct. The colour of common bricks depends entirely on the nature of the clay from which the bricks are made. Iron, magnesia, and other substances are used to colour pressed bricks, and a great many shades can now be obtained.

52. Moulded Bricks. — Almost every profile and ornament in the form of moulded bricks are now manufactured, and when properly used they give very satisfactory results. Bricks should be examined to see that they are true and that their beds are not too smooth, as this gives no clinch for the mortar. Bricks made specially for the particular work in which they are to be used are called *purpose-made bricks*. If an architect requires special patterns of moulded bricks to carry out designs, most of the larger companies manufacturing bricks will make special shapes if drawings are furnished.

53. Lime-and-Sand Bricks.—A brick composed of finely ground sand and lime is now being manufactured. This brick makes a very good appearance, but its durability so far is an open question, which time only can settle definitely.

54. Pressed Bricks. — The interior walls of churches and other public buildings are frequently lined with pressed bricks, which take the place of a plaster wall at little additional cost. This lining of pressed bricks makes a very durable and lasting surface.

55. Glazed Bricks are made in many varieties and are suitable for such uses as bathrooms, swimming baths, kitchens, light wells, etc. They should be set in Keene's or similar cement, coloured to match the enamel.

56. Mortar for Brickwork.—Cement mortar should be used where the brickwork is under considerable weight, or where it is below ground, or for chimneys above the roof. Lime putty and sand make the best lime mortar for brickwork. The mortar joints in brickwork exert considerable influence on the strength of the brickwork, and are the weakest part of the wall. Brickwork laid in lime mortar is probably about three-quarters as strong as that laid in cement mortar. Imperfectly mixed mortar or joints not well filled up lessen the strength of the brickwork. Mortar in the joint is much stronger than in cubes under a testing machine.

57. Laying Brickwork With Lime Mortar.—In freezing weather, laying brickwork with lime mortar should not be allowed, if it is possible to avoid it; but if the work must be done, the mortar should be made in small quantities, with freshly slaked lime and warm water, and used at once. The work should be well covered with sacking and boards on leaving at night and at points where the work will be at a temporary standstill. The piles of bricks should be entirely covered with canvas to protect them from rain, frost, etc. Bricks about to be laid should be wet, especially in hot weather, in order to prevent undue absorption of moisture from the mortar, as this will reduce its binding and setting properties. The absorption of a brick should not be more than 10 per cent. of its weight, if allowed to stand in water for 24 hours.

58. Efflorescence on Brickwork.—Efflorescence is a very difficult blemish to prevent or to permanently remove, and the chemistry involved in the production of the salt or salts that are to blame is difficult to establish. German chemists suggest that, before burning, the bricks be immersed in dilute hydrochloric acid, the strength of the solution to be inversely proportional to the amount of lime in the clay. This is claimed to be efficacious. Where a wall is already built and a method of keeping the efflorescence from reappearing after once being washed off is desired, painting with boiled oil or some paraffin preparation is suggested; this should render the surface of the brickwork impervious to moisture. Successive coats of alum and soap solutions are also said to be useful.

59. Waterproof Brick Walls.—A good way to obtain a waterproof brick wall is to leave a $1\frac{1}{2}$- or 2-inch space in the wall and then fill this space with an asphalt cement or other similar preparation. The two parts of the wall should be well bonded to each other with copper ties.

60. Damp Walls.—A damp wall cannot usually be made permanently dry by an inside surface coating. Such expedients at their

very best almost always give only temporary relief. The best way to get rid of dampness in walls is to remove its cause.

61. Damp-Proof Courses. — Damp-proof courses should be placed in walls to prevent the absorption of water by capillary attraction. The damp-proof course is commonly composed of slates, asphalt, stoneware, sheet lead, or similar materials in various forms. When used beneath a cellar floor, through which water is liable to force its way, these courses consist of asphalt, or a similar composition, that can be spread in a thin layer between two thicknesses of concrete.

62. Cleaning and Pointing Walls.—The work of cleaning and pointing stone or brick walls is usually done at the same time. The cleaning consists in removing dirt, stains, dust, pieces of mortar, etc., by means of steel brushes, scrubbing with dilute muriatic acid, or the sand blast. The kind of finish that is required for pointing must be carefully stated, and it is advisable to give a section of the joint, with the pointing finish required, in the specification.

CHIMNEYS AND FIREPLACES

63. Fireplace Throats.—Throats for fireplaces should be carefully constructed, and should be no larger than is necessary for the passage of the products of combustion into the flue. Cast-iron combination throats and dampers are made, which are properly proportioned for various sizes of openings.

64. Smoky Fireplaces.—A smoky fireplace is not always due to improper proportions of the fireplace itself, but often to an insufficient supply of air from the room or to down draughts of deflected air from surrounding roofs when the top of the chimney is too low. Perfectly straight flues will also very often cause down draughts. There are several patent bends now manufactured in fireclay, which can be built in as part of the flue; they are good as a preventive. Chimneys in outside walls should, if possible, have the flues protected from the chilling of the outside air, and consequent stoppage of circulation, by having at least a 9-inch wall between the flue and the air.

65. Chimney Pots of Terra-Cotta. — Terra-cotta chimney pots are manufactured in many styles, some of which are very decorative. These pots may be used to extend the height of the flues to remedy a smoking fireplace, or they may be used simply as a decorative feature.

66. Chimney Tie-Rods.—Tie-rods are used to anchor tall chimneys to roofs. The exposed ends of these rods are often finished with some decorative feature, such as a shield or rosette.

67. Floor-Joist Anchors and Hangers.—Wrought- and cast-iron hangers are now made that are built into the wall and tie the joist to it by means of a lug at the bottom of the hanger, which engages into the bed of the beam. These hangers are made in many types, and are used to a great extent in America and the Colonies. They should allow free circulation about the end of the joist in order to prevent dry rot.

68. Time Required to Build a Chimney.—The rate of building a chimney with lime mortar should not be more than 10 feet per day, as a faster rate than this will not allow mortar to set sufficiently, thus tending to squeeze out the lower joints.

69. Brick Mantels.—Brick mantels are often used for fireplace openings, and bricks are manufactured specially for this purpose by some firms. Ordinary pressed bricks, and even common bricks, however, in the care of a good designer, are very often satisfactory for this purpose.

MASON

70. Durability of Stone. — The durability of stone can often be judged by testing samples, but observation of the weathering qualities in buildings of such stones as are to be used is very essential to safe results. The atmosphere of large towns and cities contains gases that are due to coal smoke and other vapours from large manufactories and from dwellings and offices. These gases have a great affinity for water and, when combined with rain-water, or mist, form very weak acids that have a detrimental effect on marbles and limestones. Before using such stone in localities where these gases are given off, observations should be made to determine whether such stone has already been used there, and, if so, to find out its age and condition. The finish of the different surfaces of the stonework used in a building should be clearly specified. High temperatures will permanently injure almost all building stones, but up to 800° F. the average good building stone will not be materially injured.

71. Tests for Stone.—Stone is commonly tested for compression and absorption. For compression, the crushing value is seldom less than $2\frac{1}{2}$ tons and sometimes reaches 20 tons per square inch. The crushing value and weather-resisting qualities are usually greater in stones of a crystalline character than in those of an amorphous character; and the bearing power is greatest when laid on the natural bed. The safe working values for these stones are from one-tenth to one-thirtieth of the values just given. A simple test to determine the crystalline properties of stone can be made by placing a few chippings in a glass of clear water. If, after being agitated briskly for a few moments, the water shows no muddiness, but remains perfectly clear, it may safely be inferred that it is a good

crystalline stone and is suitable for building purposes, provided its resistance to compression is ample and its absorption value is not excessive.

72. Kinds of Stone.—The various kinds of stone to be used on a building must be very carefully specified, the name of the quarry, where possible, being given. Many architects require that samples of the stones shall be deposited in their offices before any work is commenced on the building.

73. Footing Stones.—Footing or foundation stones should be as large and flat-bedded as possible and should be laid on their natural beds. They should be well bedded in cement mortar, and as the footings are under the greatest pressure, they should be of the hardest stone obtainable.

74. Rough Masonry.—All rough masonry should be laid as level as possible, with the stone on its natural bed; joints should be left open for pointing on completion.

75. Ashlar Facing.—Ashlar facing should be well bonded into rough backing, either by alternating thin and thick courses of sufficient depth or by tying each stone with galvanized-iron anchors dowelled into the facing and built into the backing.

76. Setting Stonework.—In erecting stonework, care should be exercised to have the stone set on the *natural bed*; that is, on the same surface or bed as that on which it was resting in the quarry. The bed joints in ashlar work should be square to the face of the work, and not less than 6 inches wide at both top and bottom. The proper bonding of the walls, especially for ashlar and for dressings, should be given very careful attention, as well as the placing of lintels, copings, wall ties, etc. In joints on which the greatest pressure comes, the mortar should be kept back from the face, so that the edges of the stones will not be chipped off; while, in pointing, the joints should be well raked out and the pointing mortar properly inserted.

77. Staining of Limestone.—Ordinary cement will stain limestones, marbles, and some granular sandstones, and such stone should be bedded in lime mortar, with the backing of the same laid in lime mortar. If the backing is laid in cement, the back of the facing should be painted with some damp-resisting paint that will prevent the water from the cement from working into the facing, but at the same time the paint should not destroy the adhesion of the backing.

78. Methods of Fixing Stonework.—There are several methods of giving additional strength to the joints of masonry, other than that derived from the adhesion of the mortar and the weight of the stone. The most usual are by means of joggles, cramps, and dowels. Wherever any

special form of joint or fixing, such as for a raking coping stone or for a projecting cornice, is required, it must be carefully specified, with regard to both its position in the building and the form of joint or fixing required.

79. Centres for Arches.—Centres are necessary for the setting up of stone as well as brick arches; and although these are provided and built by the carpenter, they are usually mentioned in the bricklayer's or mason's specification. Centres for stone arches must be built of sufficient strength to carry the heavy weight they must often bear.

80. Strengthening Stone Lintels.—Although many stones, when used as lintels over door or window openings, will carry all the weight that is likely to come on them, in some cases they may need strengthening. This can be done by cutting out a portion at the back of the stone and inserting a steel joist, or by having some of the weight carried directly by the joist placed in the back part of the wall; in the latter case, the stone lintel is relieved of some of the weight coming on it, and it is well able to bear what weight remains. Whatever method is adopted to enable a stone lintel to bear, without cracking or breaking, the weight that will come on it should be carefully specified; and if any difficulty may be apparent as to the method to be adopted, a sketch should be inserted in the specification to show just what is required.

81. Preservation of Stonework.—It is desirable in most towns and cities to preserve the stonework of buildings by coating it with some preservative; none of these special preparations are cheap or, in the opinion of many, satisfactory. Lead-and-oil paint is often used for this purpose, but, while it may be temporarily satisfactory, it spoils the appearance of the stonework, and needs frequent renewal. Another preparation consists of paraffin mixed with creosote; but a solution known as *fluate*, which is extensively used, is said to harden and preserve limestone in new work from decay, and to arrest further decay in old work.

82. Carved Work.—The carving of stone is usually done from plaster or clay models that have been approved by the architect. Where there is danger of the finished work and carving being damaged, protection should be provided by strongly boxing the same with rough white-pine boards. Resinous woods should not be used, as they are liable to stain the stone. Patches are sometimes placed in carving where it has been damaged. The right to promptly order the removal of such work should be reserved to the architect in the specification. These patches are often very difficult to detect, as the stone is usually covered with a fine dust, which hides such patches. They may be easily detected, however, by wiping the carving with a wet rag. The patches should not be allowed to remain, as they are likely, in time, either to drop out or to become noticeable.

TERRA-COTTA, FAIENCE, AND MARBLE

TERRA-COTTA AND FAIENCE

83. Qualities of Terra-Cotta.—The terra-cotta clay is practically the same as that used for bricks, but of a better quality, a good fireclay being the best of all. The percentage of absorption of terra-cotta should not be more than 10 or 12 per cent., or acids in the atmosphere and the action of frost will have a deleterious effect on it. Therefore, the more dense terra-cotta is, the better it will be for ornamental work. A well-burnt piece of terra-cotta that is perfectly sound will ring clear when struck. The shrinkage of terra-cotta compels the making of sills, cornices, etc., in pieces short enough to reduce any irregularities to a minimum. Such pieces where exposed to the weather should be lapped at upper-surface joints. Structural terra-cotta, being hollow, should be filled with fine concrete where it is required to carry any great weight. Where this is done, care should be taken to wet the terra-cotta before filling it.

84. Weight and Strength of Terra-Cotta. — Solid blocks of terra-cotta will weigh about 120 pounds to the cubic foot. Hollow pieces with webs $1\frac{1}{2}$ inches thick will weigh from 65 to 85 pounds per cubic foot, small pieces being heavier per cubic foot than large ones. An average weight per cubic foot for hollow blocks is from 60 to 70 pounds. Authorities give the safe working strength of terra-cotta blocks in the wall at about 5 tons per square foot when unfilled, and 10 tons per square foot when properly filled solid with concrete.

85. Disadvantages of Using Terra-Cotta.—The chief disadvantage in using terra-cotta is the difficulty of avoiding shrinkage, which causes uneven lines in cornices, etc. The delivery of terra-cotta is usually very uncertain, and for this reason it is well to place orders for the same as early as possible.

86. Drawings for Terra-Cotta Work. — The detail drawings for terra-cotta work are usually made from the architect's scale elevations and sections by the manufacturer's draughtsmen, who make due allowance for shrinkage. Each block has a certain mark put on it that agrees with that on the setting-out drawings, which enables the foreman to fix its position readily on the work. This practice is common with cut stone-work also.

87. Terra-Cotta Models.—Models for ornamental terra-cotta should be submitted to and approved by the architect. These models are usually made to a proportionately larger scale, in order to make proper allowance for shrinkage.

88. Setting Terra-Cotta. — Ornamental terra-cotta should be set in Portland-cement mortar mixed in about the proportion of 1 to 2, and the blocks should be well anchored to backing wherever necessary. The pointing should be done with Portland cement stained to match the colour of the terra-cotta. Chiselling the face to get a better joint, etc., should not be allowed, as this will expose the more porous material under the vitrified surface to the action of the atmosphere, besides spoiling the appearance.

89. Protecting Terra-Cotta Work. — The protection of ornamental terra-cotta before and after setting is an important matter, and should be strictly enforced, as it is very difficult to replace broken pieces except after considerable delay and trouble, and it is often impossible to remove broken pieces without damage to the other construction.

90. Terra-Cotta Arches. — The different types of terra-cotta arches for floor construction are either of porous or of dense terra-cotta. The dense terra-cotta is the stronger, and is used for arches. The porous terra-cotta is to be preferred for partitions, and is sometimes used for grounds to which the finishings, etc., may be nailed directly. The porous terra-cotta offers more resistance to fire than the dense. Terra-cotta floor arches are built in two ways, by the *end method* and by the *side method;* the end method is much the stronger if properly built. Care should be taken to see that webs match exactly and that the joints are well filled with Portland-cement mortar and the skew backs well bedded in the same. The depth of terra-cotta floor arches varies from 6 to 15 inches, according to the span and the load that is to be carried.

91. Partition Terra-Cotta Blocks. — Partition terra-cotta blocks are made 2, 3, 4, and 6 inches thick. Porous and semiporous blocks are used for partitions, and door and other openings should be arched. These partitions are often reinforced with metal rods or with horizontal trussed wire built in the joints. Three-inch blocks are suitable for ordinary partitions, which should not be higher than 12 feet. Four-inch blocks are suitable for corridor partitions, which should not be higher than 14 feet. Six-inch partitions should not be higher than 20 feet. These blocks are set with their axes vertical.

92. Constructional Faience. — Constructional faience is practically glazed or enamelled terra-cotta; it is made in block form and built into the wall in a manner similar to terra-cotta.

93. Applied Faience.—Applied faience is made in the form of thin slabs or tiles, and is very often carried out by a subcontractor, whose business it is to specially prepare and fix such decoration. It is advisable to obtain from the contractor doing the work a drawing showing the scheme he proposes to adopt, so that the design and colour may be determined before any work is put in hand.

MARBLE

94. Marble Mosaic Floors. — If possible, mosaic floors should be used for bathrooms, vestibules, and corridors of public buildings, as they are cheaper than wood in the end. The base used with these floors and the plinth blocks of doorway finishings should be marble, so that the floors may be washed without the water coming in contact with the woodwork. *Terrazzo* is a mosaic floor made of irregular-shaped small pieces of marble or paving tiles of different colours embedded in cement and afterwards polished. These floors should be laid in Portland cement. *Ceramic* is a mosaic where the cubes or pieces are made of tile, instead of marble. It is much cheaper than marble mosaic, and makes a very durable floor. A good way to finish a mosaic floor is to soak it well with raw linseed oil, well rubbed in. This should bring out the colour, after which it may be finished with a coating of wax.

95. Marble Slabs. — To fasten marble slabs in place, copper or brass cramps, screws, or wire should be used. Exposed screws should be plated to match other ironmongery. Marble fireplace facings undergo slight expansion under moderate heat; this must be taken into account in the jointing. Marble slabs expand about $\frac{1}{30}$ inch for every foot of their length at 230° F.

96. Polishing Marble. — The use of alum for polishing marble should not be allowed, as it fills the pores and makes the marble very susceptible to stain. Slabs can be tested for this polish by simply wetting them; if it has been used the slabs will have whitish spots when the water has dried.

97. Marble Cement.—A cement for marble can be made by soaking plaster of Paris in a saturated solution of alum, after which it is baked in an oven and then ground to a powder. This cement may be coloured and, when in place, polished to imitate the marble with which it is to be used. This is practically a Keene's cement. Coloured gumlac is also used.

98. Scagliola, or Imitation Marble. — Artificial marble is now made of Keene's cement and colouring matter. It should not be used for floors, but if well made is acceptable for wainscoting, columns, cornices, etc., for inside decoration. Dado bases and plinths should be made of natural marble, as this will better withstand the contact of a mop, water, etc. An opalescent glass is now made, which as a substitute for marble is used for covering walls of operating theatres, public baths, etc., and also for floor slabs, urinal stalls, etc. The advantages of artificial marble are its cheapness, freedom from cracks and flaws, and the fact that it can be made in sizes and shapes that would be almost impossible or very expensive in real marble.

99. Bricks for Pavements. — Bricks on edge for pavements in stables, courtyards, etc., are preferable to stone, and should be laid in cement mortar and well grouted with neat cement. A good, hard, impervious brick should always be selected.

100. Magnesia-Sawdust Flooring. — A flooring consisting chiefly of sawdust, magnesia, and asbestos is often used for lavatory floors. It has the advantage of being easily formed into gutters and turned up walls, etc. Care, however, must be taken that this flooring composition does not come in contact with iron or woodwork when in a plastic condition.

101. Plastic Floors. — Flooring made of asphalt is impervious to water, and is therefore a most sanitary pavement that is very suitable for stables, etc. It may be from $\frac{1}{2}$ inch to $1\frac{1}{4}$ inches thick, depending on its use. The surface of the concrete foundation on which the asphalt is laid should be perfectly dry and free from dust when the asphalt is laid.

Gutta-percha, or rubber, pavement is sometimes laid in hospitals, where quietness is essential, but its cost prohibits general use. It should be laid on a concrete base. It is often laid as tiles designed on an interlocking principle.

Tar paving for courts, playgrounds, etc., should be used only on flat surfaces. This kind of paving is soft and agreeable to the tread, and is composed of heated gravel or broken stone about $\frac{3}{8}$ inch in diameter mixed with boiling tar or a mixture of tar and asphalt. Where there is much traffic, two coats should be laid on a bed of concrete, the under coat being about $1\frac{1}{2}$ inches and the top coat about $\frac{3}{4}$ inch in thickness.

CARPENTER AND JOINER

TIMBER

102. Market Forms of Timber. — The following is a list of the principal forms into which softwoods are converted for the market: A *log*, or *stick*, is the trunk of a tree after it has been felled and the branches have been taken off. A *balk* is a log roughly squared into shape by an axe or saw; it is sometimes called *whole timber*. A *plank* is a squared piece of timber generally sawn from a balk. It ranges from 2 to 6 inches in thickness, is 11 inches and upwards in width, and from 8 to 21 feet long. A *deal* resembles a plank, but is less than 11 inches and more than 7 inches wide, and is not more than 4 inches thick; *whole deals* are 2 inches or more thick, and *cut deals* less than 2 inches thick. A *batten* is similar to a deal, but is only 7 inches or less in width, and generally between $1\frac{1}{2}$ and 2 inches thick. A *quartering* is squared timber varying in size from 3 inches by 3 inches to $4\frac{1}{2}$ inches by 4 inches. Forest timber is better than that grown

in open spaces, and timber grown in dry ground is better than that grown in wet ground. It will be necessary in writing specifications to give the names of the particular kinds of timber to be used for different purposes on the work, and to state the qualities that will be demanded in the same.

103. Woods for Special Purposes.—For partitions, framings, etc., the various kinds of pine and spruce that are most easily procured in the country in which the material is to be used should be specified.

For heavy framework in beams, floor joists, roof trusses, etc., such as are used in warehouse and factory construction, blue gum, teak, oak, Oregon pine, and pitch pine may be used.

For window sills, oak or teak.

For treads of stairs, oak and teak in best work.

For floors, teak or oak, Baltic pine, pitch pine, and Norway spruce.

For piles, oak, elm, teak, greenheart, pitch pine, Oregon pine, and Baltic pine.

For posts and sleepers in the ground, durable in wet situations, Jarrah, oak, teak, chestnut, elm, and black spruce.

For interior joinery finishings, mahogany, oak, walnut, kauri pine, American pine, pitch pine, etc.

For foundry patterns, mahogany and American pine.

104. Shrinkage.—The shrinkage of timber is greatest transversely to the grain, and this should be avoided or equalized throughout the framing of a building as much as possible. It is the principal cause of cracks in plaster, binding doors, and windows, and other faults of a similar nature. Even when thoroughly seasoned there is liable to be shrinkage in finishing wood, and this should be provided for in panelling, framing, etc.

105. Stock Sizes of Timber.—Nearly every shipping port in Great Britain has its own special stock sizes of timber ; it is therefore impossible to give anything but an indication of the more common sizes. It is better and cheaper to specify the usual stock sizes of the district, although almost any other size can be obtained owing to shippers importing what are known in the trade as unsorted lots. The following are some of the more common sizes :

Baltic red wood and white deal or white wood, $4'' \times 2''$, $5'' \times 2''$, $6'' \times 2''$, $6\frac{1}{2}'' \times 2\frac{1}{2}''$, $7'' \times 2\frac{1}{2}''$, $8'' \times 2\frac{1}{2}''$, $9'' \times 2\frac{1}{2}''$, $7'' \times 3''$, $8'' \times 3''$, $9'' \times 3''$, $11'' \times 3''$, $12'' \times 3''$, $13'' \times 3''$, and even larger sizes.

Matched-pine flooring, $\frac{3}{4}$, 1, $1\frac{1}{8}$, and $1\frac{1}{4}$ inches, and 3, 4, 5, 6, and 7 inches wide ; the widths given are for the face and do not include the tongue.

Matched-oak and matched-maple flooring are generally run to order.

Matched-pine boarding or lining, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ inch thick, and 3, 4, 5, and 6 inches wide.

Finishing timber is sold in lengths of 10 to 20 feet, and with a maximum width of 18 inches. In quartered oak, the usual sizes are $6'' \times 1\frac{1}{4}''$,

6″ × 1″, 6″ × $\frac{3}{4}$″, 9″ × $\frac{3}{4}$″; in plain oak, 1 and $1\frac{1}{4}$ inches thick of the same widths as quartered oak. Cypress is sold in the same widths as quartered oak, but 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, and 3 inches thick. Yellow poplar is $\frac{1}{2}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, and 4 inches thick and from 8 to 18 inches wide. Yellow pine is sold 1 and $1\frac{1}{4}$ inches thick from 4 to 13 inches wide, also 2 and 3 inches thick and 8 inches wide. Mahogany is usually imported in the log; it may be obtained in almost any width that can be handled and up to any practical length.

106. Timber Defects.—The various defects of timber are knots, knot holes, splits, shakes, waney edges, rot, rotten streaks, worm-holes, torn grain, loosened grain, seasoning or kiln cracks, and sap stains. Although the architect may specify according to the usual qualities adopted by the timber merchants, it might be better to state specifically and exactly what defects, if any, will be allowed, and leave the quality to the contractors, as the methods of designating the different qualities are rather complicated and frequent changes are made in them; they also differ somewhat in different localities. The common terms of classification may be obtained from almost any timber merchant.

107. Bleeding Timber Trees.—The bleeding of pine trees for their resin, a process to which only the long-leaf and Cuban pine are subjected, has generally been regarded as injurious to the timber. Both durability and strength, it was claimed, were impaired by this process, and in the specifications of many architects and large consumers, such as railway companies, *bled* or *boxed* timber was excluded. However, it has now been proved conclusively that bled timber is as strong as unbled if of the same weight; that the weight and shrinkage of the wood are not affected by bleeding; that bled trees contain practically neither more nor less resin than unbled trees, the loss of resin occurs only in the sap wood, and therefore the durability is not affected by the bleeding process.

108. Dry and Wet Rot.—The disease of timber known as *dry rot* is difficult to eradicate, but is prevented by sunlight and circulation of air. For this reason, framing timbers should always, where possible, have their ends free. To eradicate dry rot, cut away and burn off all affected parts and coat all sound timber left with boiling tar or a cold solution of corrosive sublimate, and also provide for a good circulation of air about the timber. Dry rot is also very often caused by not removing all shavings and chips of wood from the material forming the under filling, or bottoming, of concrete or tile floors, vestibules, etc. Once started under favourable conditions, that is, a little heat, moisture, and want of air, the fungus spreads very rapidly and will travel through thick walls. Newly laid wooden floors should never be entirely covered with linoleum, cork carpet, or similar material.

Wet rot is avoided by keeping timber dry or else continually wet. If neither of these conditions can be had, impregnate the wood thoroughly

with creosote, which will also keep the teredo, a wood worm, from attacking the wood when placed in salt water.

109. Seasoning Timber.—To air-season timber generally requires from 2 to 4 years. Water seasoning, which is simply a method of dissolving the sap from the wood by soaking in running water for from 2 to 4 weeks, instead of getting rid of the sap by evaporation, as by the other methods, demands air or kiln drying afterwards to free it from moisture and remaining sap.

110. Air- and Kiln-Dried Finishings.—Interior and exterior finishings should be both air- and kiln-dried, and, when possible, should be stacked in the building for some time before being put in place, in order that they may adapt themselves to the atmosphere of the building.

111. Effects of Exposure.—Exposure to air and moisture, which is prevented by varnishes and paints, has the following effects on different kinds of woods:

Mahogany, Baltic fir, Norway fir, white pine, and chestnut become darker on exposure.

Oak and walnut are bleached by sunlight.

Elm, teak, and greenheart are hardened by immersion in water.

Oak and firs are softened by immersion in water.

Pines and mahogany are rapidly destroyed by immersion in water.

Oak, spruce, chestnut, and larch become hard on exposure to the air.

Baltic fir, baywood, and certain species of mahogany become brittle on exposure to air.

112. Measurements for Joiner.—The joiner should take his measurements for finished inside work at the building and not from the architect's drawings, and a note stating this requirement should be made in the specifications or on the drawings.

FLOORS AND PARTITIONS

113. Size of Floor Joists.—Floor joists and tie-beams should be crowned slightly at the centre to allow for the sagging when the weight of the floor, etc., is placed on them. The following are the most common sizes in use:

For spans from 6 to 8 feet, $6'' \times 2''$ or $6\frac{1}{2}'' \times 2\frac{1}{2}''$.

For spans from 8 to 10 feet, about $7'' \times 3''$.

For spans from 10 to 15 feet, $8'' \times 3''$ to $9'' \times 3''$.

For spans from 15 to 18 feet, about $11'' \times 3''$.

The section to be used will depend on the kind of timber and the country from which it is imported.

114. Wall Plates. — Care must be taken to specify the size and description of wall plates in every case, and if any doubt is likely to exist

from the description of what is intended, a sketch section of the plate showing the method of fixing in the wall and the position the joist is to occupy in regard to it should be inserted in the specification.

115. Trussed Partitions. — If any trussed partitions are to be executed, they should be carefully described and the sizes of their various members given, as also the method of trussing required.

116. Loads on Floors.—The weights which floors should be calculated to carry vary considerably with the class of structure that is being dealt with, but for ordinary practice it will be quite safe to allow the weights given in Table I.

TABLE I

SUPERIMPOSED LOADS ON FLOORS

Type of Building	Superimposed Loads Per Square Foot Pounds
Dwelling houses, offices, and hotels.	70
Schools	100
Churches and theatres . .	120
Ball-rooms and drill halls .	130
Workshops, factories, and warehouses.	100 to 200 and upwards

117. Deafening Floors. The method to be adopted for deafening the floors and partitions in a building must be clearly stated in the specification. The usual method is to fill the space between the studs of the partition with slag wool, and between the joists of a floor with similar material resting on boards which lay on battens spiked to the lower side of the joists.

118. Floor Joists Near Flues.—When the ends of floor joists come near the smoke flues, they should be protected in some way. They are often kept away from the flue by resting their ends on special joist hangers, or else their ends when built into the wall are protected by means of an iron shoe placed over them.

119. Strutting. — The strutting for floors should be fastened in place as soon as the floor joists are levelled. Strutting between the studding or standards helps greatly to stiffen the partitions. This strutting should be placed at an angle of 45°, the adjacent ends of strutting being on the same level. This makes a stiffer job and gives a better chance for the plaster key than horizontal strutting.

120. Studding and Joists.—The lengths of studding and joists should conform as nearly as possible to the stock lengths of timber. This means a considerable saving in a large building, as there is less cutting to do and less waste of material. The cutting of joists to fit over the wall plate is customary, but it is better to rest the joist directly on the plate,

as this gives the strength of the full depth of the joist. The space between the joists from wall to under side of floor is sometimes filled with brickwork to form a fire-stop. The brickwork should be kept not less than 1 inch below the floor to allow for the shrinkage of the joists. Studding and joists are spaced from 12 to 16 inches and joists sometimes 18 inches, centre to centre.

121. Interior Floors.—Oak, red pine, pitch pine, and white wood are used principally for interior floors. Where carpets are not to be used, the flooring pine should be planed, scraped, and varnished or waxed. Oak or parquetry floors should always be placed on rough flooring laid diagonally. Where floors form a butt joint at door openings, etc., the joints should be strengthened with metal slips. Where single floors with carpets are used, the lower member of the skirting is sometimes kept $\frac{3}{16}$ inch off the floor in order to allow the carpet to slip under. Where floors are to be varnished and no carpets used, the skirting should be well seasoned and, if possible, a grooved border with the base tongued into it run round the room. If this cannot be done, the skirting should fit the floor as closely as possible or be tongued into it. Where double floors are used, the skirting should run to the rough floor and the finished floor should butt against this skirting ; this allows for shrinkage of the skirting and prevents an open joint at the floor due thereto.

122. Parquetry. — Parquetry is a mosaic of woodwork used for floors, and is composed of small pieces sometimes tongued and grooved together, but more often laid with a butt joint. Usually, the parquetry is $\frac{5}{8}$ or $\frac{7}{8}$ inch in thickness or simply a veneer glued to canvas.

123. Space for Door Mats.—A mat space sunk in the vestibule floor is often used in residences. It keeps the door mat in its proper position and should be deep enough to bring the surface of the mat on a level with the floor.

124. Rolling and Folding Partitions.—Rolling and folding partitions, made of interlocking wooden strips, are manufactured and much used for the subdivision of Sunday schools and other schoolrooms. They roll either into horizontal or vertical pockets, and are somewhat similar to the rolling shutters of roll-top desks. Folding doors are also largely used and are manufactured by many good firms.

ROOFS

125. Pitch of Roof.—In cold climates, where the air holds moisture, and rain and snow are driven by high winds, the pitch must be steep, to prevent the loosening of shingles, slates, or tiles by the wind, and to cause snow and moisture to be quickly shed from the roof. In hot countries,

the lack of rain makes it unnecessary to give the roof more pitch than enough to shed the water; but the roof must be well constructed and water-tight, for when rain falls in hot regions it does so in large volumes. Rapid evaporation is a great help in preserving the roof, for when the rain ceases the roof is soon dried, and the conditions tending toward corrosion or decay of the materials are removed. In Table II is given a list of roofing materials and the minimum pitch advisable for each when laid on roofs.

TABLE II

MINIMUM SLOPE OF ROOFING MATERIALS

Roofing Material	Minimum Slope
Lead	2 inches in 10 feet
Zinc	2 inches in 10 feet
Copper	2 inches in 10 feet
Tin	2 inches in 10 feet
Asphalt	2 inches in 10 feet
Composition roofing	2 inches in 10 feet
Corrugated iron	12° with the horizontal
Sheet iron	12° with the horizontal
Slates	26° with the horizontal
Pan tiles	33° with the horizontal
Plain tiles	45° with the horizontal
Thatch	45° with the horizontal
Shingles	45° with the horizontal

126. Roof Boarding or Sarking.—The roof boarding is very often put on diagonally, as it stiffens the entire building considerably and much more so than will roof boarding laid horizontally.

127. Shingles.—Shingles wider than 7 inches should not be allowed, as they are apt to curl. Shingles should have two nails apiece, and should not be laid with more than a 5-inch gauge.

128. Hips.—Hips at an angle of 45° on the plan are the only ones suitable for neat work, as unequal angles make unequal widths for the tiles or slates on opposite sides of the hip. Where roofs on either side of the hip have unequal pitches, the tiles or slates will have different widths to the weather on the two pitches, if it is desired that the butt lines of the hip tiles shall coincide with those of the roof. This does not look well, however, and is very seldom done.

129. Mansard-Roof Valleys.—The valleys of Mansard roofs should be wide, especially on the low pitch, and the edge slates should be raised on a cleat to prevent water from working back under the shingles by capillary attraction. The sudden change in pitches at the hip is liable to shoot the water under the slates.

130. Boxed Gutters.—When a boxed gutter is used, it should be as large as possible, with a good clear drop from the ends of the tiles or slates. A hanging gutter, or rhone, is the best gutter to use where it is possible to do so. Box parapet gutters demand great care in designing.

131. Snow Gratings.—Snow gratings or cradling are used for large box gutters to prevent them from clogging with snow. These gratings are usually made of $2'' \times \frac{7}{8}''$ cleats nailed about $\frac{1}{2}$ inch apart to bearing pieces adjusted to the gutter width and cut out at the bottom to allow the flow of water in the gutter. The length of the sections should not be more than 6 feet, in order that they may be easily handled.

DOORS AND WINDOWS

132. Door and Window Frames. — Door and window frames in brick or stone walls should be substantially fixed to walls by bolts, built in, or wedges. Door sizes to the finished jamb should be given on drawings, and, in framing, a total allowance of about 5 inches in width and about 3 inches in height is made for false jambs and head. The carpenter should block well behind the false jambs, especially opposite the hinges. This is very important in connection with double-acting doors. The allowances spoken of here are obtained from the full-size details.

133. Stock Doors.—Doors that are kept in stock by joinery manufacturers may be obtained in almost any size from 6 to 7 feet in height and from 2 to 3 feet in width, the thickness varying from $\frac{7}{8}$ inch to $1\frac{3}{4}$ inches. They are made in a variety of woods. Some manufacturers carry oak-veneer doors in stock also. The cores of veneered doors are made of white or yellow pine or chestnut, as these woods take glue.

134. Door Panelling. — The panelling of a door should be so arranged that the lock will not cut into the tenon of a rail, and the hinges should line up with the panelling.

135. Door Hanging.—A good appearance is obtained by projecting the face of a door $\frac{1}{8}$ inch beyond the edge of the jamb lining; this covers the joint between the jamb and architrave and gives the hinges more clearance. Doors leading to pantries, lavatories, bathrooms, and bedrooms should swing in such a way that the greater part of the room will be hidden until the door is wide open. Closet doors should open in a direction that will give the most light to the closet from windows and lighting fittings. Outside doors to public buildings should open outwards.

136. Double-acting doors are pivoted top and bottom, and various types of spring hinges are made for this purpose. The back of the hanging stile should be rounded, so that it may be swung close to the jamb and still have clearance. The pivot that is let into the bottom rail of the door is preferable to the type that is sunk in the floor, the latter being liable to become filled with dust or dirt. Sliding doors are hung on tracks and hangers, of which there are a number of makes on the market.

137. Bookcase and Pantry Doors.—The doors of bookcases are often glazed with plate or leaded glass, and they either slide or are hinged. The hinged doors are preferable, as sliding doors are very difficult to wash on the inside. For pantry cupboards, sliding doors are not so objectionable, as the contents of the cupboard are usually much easier to remove than books. The space in pantries is limited also, and the swinging doors take up considerable room when open.

138. Door Stops.—The stops of doors are usually simply planted on jambs. A better job, however, is obtained by housing them into the jambs.

139. Terms Applied to Hand of Doors.—The hand of a door is always determined from the outside. A door opening inwards, and having a mortise or rim lock fixed on the right, is a right-hand door ; if fixed on the left, it is a left-hand door. A door opening outwards, and having a mortise lock fixed on the right, is a left-hand door ; if fixed on the left, it is a right-hand door. A door opening outwards, and having a rim lock fixed on the right, is a right-hand door ; if fixed on the left, it is a left-hand door.

140. Door Bevels.—The hand of a door has much to do with the bevel of the latch bolt or the front of the lock where the stile is bevelled. Some locks are made reversible ; that is, they may be used regular or reversed. The meeting rails of sliding doors are either bevelled, bevelled astragal, rabbeted, or plain, and this should be kept in mind in ordering or specifying the locks. The usual bevel for doors is $\frac{1}{8}$ inch in $2\frac{1}{4}$ inches. It should be stated whether the doors have bevelled edges or plain.

141. Entrance Side Lights.—The lights placed at the sides of entrance doors should not be wider than 8 inches if of leaded glass, as they would afford easy access to a burglar. Other large leaded-glass lights in accessible positions should be avoided for the same reason.

142. Glazing Rabbets.—The sides and backs of glazing and stops for mirrors, etc., should be painted black, to prevent reflection from the edge of the glass ; and for lights of large size, the backs of the stops should have felt glued to the surface of the wood to form a cushion for the glass.

143. Wooden Dowels.—In the best cabinetwork, wooden dowels, or pins, and glue are used as much as possible to the exclusion of nails and screws.

144. Capillary Attraction.—The tendency of water to work itself between two closely adjacent surfaces, against the force of gravity, known as *capillary attraction*, should be guarded against in window-sash design. The lower rail of the lower sash in particular should be taken care of by throating, and the sill should be well pitched and rabbeted for the sash.

Where French casements are used, the meeting rails should be bevelled, rabbeted, and grooved, and the hanging stiles tongued into jambs. See Fig. 2. The grooves in the jambs and meeting rails should be sufficiently large to allow the water that may work into them to run away.

FIG. 2

145. Water Bars. Metal water bars sunk into wood and stone sills, well set in asphalt or other cement, keep water from working back under the sill. Another method is to make the grooves in the wood and stone sills larger, and fill up the groove with cement when bedding in the window frame.

146. Position of Casements.—The washing of a window should always be considered in connection with its position, and casements should be made to swing inwards if possible, although such windows are harder to make weather-tight, as they are easier to wash. A casement on the second floor that swings outwards is almost impossible to wash on the outside, greatly to the annoyance of the inmates of the house.

147. Sash Weights.—The weights for the upper sash should be at least $\frac{1}{2}$ pound heavier than the sash itself, in order that the sash may be kept tight up against the head. The weights for the lower sash should be about $\frac{1}{2}$ pound less in weight than the sash, so that the lower sash will stay down. In arranging for the sash weights to be used, the correct method is to weigh the sashes with glass complete before fixing and provide for the weights accordingly. Spring sash balances are made which do away with the weights, but they are not reliable.

In asylums and similar institutions sash weights are sometimes dispensed with. The upper and lower sashes are attached to the same cords, the weight of the upper sash thus balancing that of the lower; therefore, when the lower sash is raised the upper sash falls. Another method is to fix cog-wheels, made of gunmetal, to either side of the window case, and lengths of ratchet bars, which fit into the cogs of the wheels, to the upper and lower sashes. On lifting the lower sash, the ratchets actuate the cog-wheels and thus lower the upper sash. These windows are usually fixed so that the sashes cannot be opened more than 4 or 5 inches.

148. Window Stops.—Window stops should be fastened in place by stop-adjusters, which are brass sockets countersunk into holes bored in the stop and through which the screws fastening the stop go. These sockets are grooved at the bottom, and thus allow the adjustment of the

stop in case the sash cramps. Brass screws should be used in preference to iron.

149. Devices for Large Windows.—For very large windows where the meeting rails are too high to reach, a turnbuckle catch should be placed on the stile of the lower sash with a strike plate let into the pulley stile. Such sash should also have a countersunk metal socket in the top rail of the upper sash, in order that it may be lowered by means of a wooden rod with a metal hook that fits into the socket.

150. Provisions for Curtain Rods, Rollers, Etc.—In detailing window finishings, etc., sufficient plain surface should be left on which to fasten curtain rods, rollers, etc.

151. Skylights. — Skylights should be protected with wire where there is danger of breakage from falling objects, as at the base of light wells. Where the skylight is not double, provision should be taken to carry away the water of condensation that forms on the under side of the glass. This is done by grooving the sash bars, or astragals, or placing small metal troughs under them. These grooves, or troughs, are led to the lowest point of the skylight and discharged through the curb to the roof.

152. Outside Window Shutters. — Outside shutters should be hung by butts, with sufficient swing to clear the brick or stone jambs or wooden boarding, as the case may be. Inside shutters are used in the folding and sliding forms. The first type fold into pockets in the jambs and the second type are counterweighted and slide, in guides at the jambs, into pockets below the sills.

STAIRS

153. Risers and Treads.—The riser and tread of a staircase should always bear a certain relation to each other; a good rule is to have the product equal 66. These dimensions do not include the nosing of the tread. Where the riser is 7 inches high, not less than 13 are required for headroom. The maximum number of treads in any flight of stairs should be twelve, where possible, and the minimum, three.

154. Winders. — Winders should not be used if it is possible to avoid them; but if they are used, there should be an odd number in order that an angle that will be difficult to clean may not be formed in the corner.

155. Hand Rails.—The height of hand rails should be from 2 feet 7 inches to 2 feet 9 inches from the top of the tread measured on a line with the face of the riser. At landings, the rail should be 1 or 2 inches higher.

WAINSCOTING AND MOULDINGS

156. Wainscoting.—Where wainscoting butts against the architrave of a door or window casing, in the best work, it should be tongued into it. This allows the wainscoting to shrink away from the finishings slightly without opening the joint. It is a good rule in setting out wainscoting to keep the individual pieces reasonably small and to have the least dimensions transverse to the grain, for the purpose of lessening as much as possible the results of the inevitable shrinkage of the material. The setting out of wainscot panelling should not be left to the joiner, but each side of the room should be set out by the architect. Architrave blocks are used to stop mouldings of casings above the floor level, where they are less liable to be broken or chipped. Mitred casings, if small, should be tongued and grooved; large ones should be tongued.

157. Mouldings.—The mouldings used to fasten mirrors in place or to cover joints between tilework and woodwork of the fireplace opening should be screwed in place, so that they can be easily removed. If the architect wishes the contractor to follow the contours of the mouldings exactly as shown on the full-size details, it should be emphasized by distinctly stating that no mouldings that are not exactly according to detail will be accepted, as the contractor is liable to change the contours somewhat at times in order to save undercuts, or a second running through the machine. It should be remembered that undercut mouldings cannot be scribed, but must be mitred. Undercut mouldings are more expensive than mouldings that can be cut in one run of the machine. In Fig. 3 (*a*) is shown a moulding that can be run in one position with one knife, and at (*b*) is shown the same moulding so drawn that it will require two runs and knives.

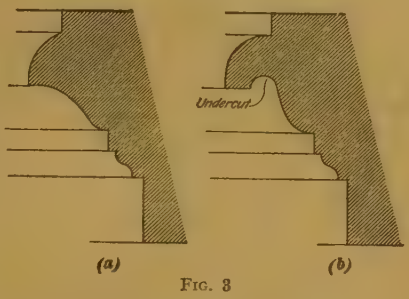

FIG. 3

158. Curved Material.—Curved mouldings for interior work should be curved or run in a machine and not kerfed. Curved panels and plain surfaces should be bent veneer on a built-up pine core. Self-curved timber makes the best work where it is possible to obtain it, and is, of course, more permanent and durable than a timber curved by kerfing, keying, or steaming. Where a curved moulding meets a straight one in panel or other work, it should be stated whether the mitre is to be straight or curved.

PORCHES

159. Porch Pedestals. — Where pedestals are placed on either side of porch steps, they should be of brick or stone if permissible. If made of wood, they should be supported on solid brick or stone foundations and the wood kept as far from the ground as possible.

160. Porch Floors. — Fir, white pine, and cypress are used for porch floors and the like. The grooves should be generously painted with white lead and the tongues well driven into place. Straight-grained timber is best for outside floors, and all flooring should be thoroughly seasoned. The flooring of porches should run outwards from the building or in the direction of the fall; the ceiling should also run in the same direction. The pitch of the floor should be about $\frac{1}{8}$ inch to the foot. No end wood should be allowed, as it is very absorbent and usually rough. The butt joints at angles of porches should be joined by a metal tongue. Heavy strap iron is frequently used.

161. Porch Steps.—Wooden steps for porches, etc., should have treads formed of cleats with $\frac{3}{8}$- or $\frac{1}{4}$-inch spaces between them for drainage; or, if made of one piece, each step should have a suitable number of $\frac{1}{2}$-inch holes bored for the same purpose as the cleats.

162. Porch Posts.—Plain porch posts are often set on iron shoes that raise the base 2 inches from the floor, thus protecting it from moisture. All porch columns, posts, etc., should have their end wood thoroughly soaked with white lead.

163. Screening for Porch Panels. — A good screening for panels under porches is made of punched-steel plate thoroughly painted and screwed to rabbeted frames.

MISCELLANEOUS WORK

164. Grounds.—Grounds for plaster, finishings, etc., should have bevelled edges to form a key for plaster; and when joists or studding are more than 2 inches thick and it is possible to do so, 1″ × 1″ cleats should be nailed on them to receive the laths, as the greater width of the joists and studding cuts off a good deal of the keys of plaster in the length of a lath. Plaster grounds for finishings, etc., should be about $\frac{1}{4}$ inch narrower than the finishing that is to be nailed to them, in order that the finished work may not have too much lap on the plaster. In Scotland, *strapping* walls and *brandering* ceilings are equivalent terms, while *standards* is the term used for studding. It is customary to space the joists at 18 inches from centre to centre, and to nail *branders* at 14-inch centres to the under side of the joists to receive the lathing.

165. Furring for Brick or Stone Walls.—The furring for brick or stone walls often consists of hollow bricks, which may be bonded into the wall and into which nails may be driven to fasten finishings. Laths and wooden bricks are often built into brick walls to afford nailing for wooden furring on which the laths are placed. Stone walls are plugged with wood for the same purpose, but the hollow bricks, if they can be arranged properly, though more expensive, are to be preferred. In Scotland, furring is called *strapping*, and the wooden plugs *dooks*.

166. Kitchen Fittings.—Kitchen work tables are usually 2 feet 8 inches from the floor. The bread board is often covered with block tin or sheet zinc, or is of marble or glass. The drip board of the sink is most convenient on the right-hand side. Closets for brooms, dust pans, table leaves, and scuttles should be provided for the housekeeper. Bins for sugar, flour, etc., are usually placed under the counter shelf of the pantry cupboard; they should be provided with vermin-tight covers, and are sometimes lined with sheet tin.

167. Refrigerators.—In America and the Colonies, outside ice doors for refrigerators are used and are a great convenience, combining the keeping of the refrigerator inside and avoiding the entering of the house by the iceman. Refrigerators of standard makes are supplied with these doors, and their size and height from the floor, together with other particulars, may be obtained from the manufacturers. The jambs and casing of these doors should be protected with sheet zinc or copper.

168. Built-In Wooden Seats.—Cushioned seats should be pitched back slightly, and an upset, which will serve to keep the cushion in place, should be put on the nosing. The height of the seats from the floor should be from 16 to 19 inches if the seats are without cushions, and about 2 inches less if cushions are used. Billiard-room seats should be up one or two steps, so that persons seated on them may have a good view of the table top. Seat tops are often fitted with hinged panels and the interior of the seat used for various purposes. If plaster is exposed inside the seat, it should be lined with narrow $\frac{5}{8}$-inch lining.

169. Skirtings.—In public buildings, skirtings should be made of slate, marble, glass, cement, or some other non-absorbent material.

170. Bookcase Shelves.—The shelves for bookcases are from 6 to 12 inches deep, and should have one coat of varnish. They should be made adjustable by ratchets and cleats, by strips with holes and pins, or by grooving the divisions; the last method has many advantages. The average number of books allowed for each square foot of shelving is nine.

171. Hearth Arches.—Where hearth arches are used to support large fireplace hearths, iron rods may be built into the chimney and allowed to pierce the trimmer against which the arch abuts, being fitted on the

opposite side with bolts and washers. This will prevent the trimmer from giving, by reason of the thrust of the arch.

172. Chimney Angles.—Where chimneys are reduced in width at any floor, the flues are often too close for safety to the trimming joists, at the angle where the chimney is reduced in size, and the flue is on a pitch. This should be watched, and avoided by throwing the flue over at a lower lever or keeping the joists well away from the angle.

173. Gate and Clothes-Line Posts.—Gate and clothes-line posts should have bases formed of two pieces of timber at right angles to the post with braces from post to base. All this work below ground should be thoroughly tarred or creosoted.

174. Bank Counters.—The counters used in banks for counting money or at tellers' windows are made of the best Spanish or other hard mahogany. Sometimes they are covered with plate glass or marble. The proper height for the working counter is about 41 inches. The shelves at the windows are sometimes placed a few inches higher.

175. Cutting for Piping.—All cutting of joists, etc., necessary for the running of piping should be done by the carpenter. Where piping runs at right angles to the joists, care should be taken to see that the carpenter does no excessive cutting, also that the cutting is done as close to the bearings as possible, so as not to weaken the joists more than necessary.

IRONMONGER

WINDOW AND DOOR FURNITURE

176. Specifying Ironmongery.—Manufacturers issue voluminous catalogues from which the architect may select and specify locks, hinges, butts, and other necessary ironmongery with great exactness. He should therefore obtain the catalogues of the reliable firms and make selections therefrom. The finished ironmongery for a modern interior may be had in any style to harmonize with the style of the rooms, and the surface finishes afford a very wide choice. In specifying ironmongery for special conditions, it is best to consult a practical ironmonger, as improvements are constantly being made which may escape the notice of the architect.

177. Stop-Adjuster.—A stop-adjuster is sometimes used to fasten window stops. These adjusters allow slight changes in the position of the stops because of any shrinkage that may occur.

178. Sash Appliances.—Cheap sash pulleys or spring sash balances should be avoided in good work. A great many sash fasteners are manufactured, and care should be taken in making a selection to get one that

pulls the sash firmly into position when locked and which cannot be thrown by slipping any instrument between the meeting rails. The best quality of Russian hemp cord, or chain, should be selected for hanging windows. Pivots for sashes are now manufactured which make it possible to revolve the sash either at the centre of the hanging stiles or at the centre of top and bottom rails. This enables the washing of the entire window from the inside, and does away with weight boxes. There are also many good patent methods of opening sash and casement windows inwards for cleaning purposes. In some districts the by-laws provide that all upper-floor windows shall be fitted so that they can open inwards.

TABLE III

WEIGHTS, DIAMETERS, AND LENGTHS OF SASH WEIGHTS

Weight Pounds	Diameter Inches	Length Inches	Weight Pounds	Diameter Inches	Length Inches
4	$1\frac{3}{16}$	$14\frac{5}{8}$	12	$1\frac{11}{16}$	23
$4\frac{1}{2}$	$1\frac{3}{8}$	13	$12\frac{1}{2}$	$1\frac{3}{4}$	23
5	$1\frac{3}{8}$	$14\frac{1}{8}$	13	$1\frac{3}{4}$	$23\frac{1}{4}$
$5\frac{1}{2}$	$1\frac{7}{16}$	$13\frac{5}{8}$	$13\frac{1}{2}$	$1\frac{3}{4}$	$23\frac{1}{2}$
6	$1\frac{7}{16}$	$14\frac{3}{4}$	14	$1\frac{13}{16}$	$22\frac{1}{8}$
$6\frac{1}{2}$	$1\frac{7}{16}$	16	$14\frac{1}{2}$	$1\frac{13}{16}$	$22\frac{3}{4}$
7	$1\frac{9}{16}$ and $1\frac{7}{16}$	$15\frac{5}{8}$ and $17\frac{1}{2}$	15	$1\frac{7}{8}$	$23\frac{1}{4}$
$7\frac{1}{2}$	$1\frac{1}{2}$	$18\frac{1}{2}$	$15\frac{1}{2}$	$1\frac{15}{16}$	$23\frac{1}{8}$
8	$1\frac{1}{2}$	$18\frac{3}{4}$	16	$1\frac{7}{8}$	$23\frac{1}{4}$
$8\frac{1}{2}$	$1\frac{1}{2}$	20	$16\frac{1}{2}$	$1\frac{15}{16}$	$23\frac{1}{4}$
9	$1\frac{1}{2}$	21	17	$1\frac{7}{8}$ and 2	$27\frac{1}{8}$ and 23
$9\frac{1}{2}$	$1\frac{5}{8}$	$18\frac{3}{4}$	$17\frac{1}{2}$	$1\frac{13}{16}$	$28\frac{1}{4}$
10	$1\frac{5}{8}$	$19\frac{1}{2}$	18	$1\frac{13}{16}$	$28\frac{5}{8}$
$10\frac{1}{2}$	$1\frac{11}{16}$	20	$18\frac{1}{2}$	$1\frac{7}{8}$	$28\frac{1}{2}$
11	$1\frac{11}{16}$ and $1\frac{5}{8}$	21 and $22\frac{3}{4}$	19	$1\frac{7}{8}$	$28\frac{3}{4}$
$11\frac{1}{2}$	$1\frac{11}{16}$	$22\frac{3}{4}$	$19\frac{1}{2}$	$1\frac{15}{16}$	$28\frac{5}{8}$
			20	$1\frac{7}{8}$	$31\frac{1}{4}$

179. Window Weights. — Window weights in common use are made of cast iron, and are about $1\frac{3}{4}$ inches in diameter with a perforated and flattened end through which the cord or chain is fastened. No particular weight is specified, as a rule. Sectional interlocking weights that are rectangular instead of round are now made; they are built up from below, to correspond with the weight of the sash. The weights and dimensions of *round iron sash weights* are given in Table III. These sizes and weights are as generally furnished to the trade, although it is almost impossible to give these data with any degree of accuracy, as the different

manufacturers vary the diameters of the weights slightly, and this changes the length measurement. The weight of lead is about 80 per cent. greater than of cast iron ; hence, lead sash weights must be resorted to where the construction of the pockets is too narrow to permit the use of iron weights.

180. Casements.—Casements should be fitted with rod adjusters, by means of which the sash may be fixed rigidly when open and thus be prevented from banging in the wind.

181. Locks.—The number of keys desired for each lock, and whether or not master keys are desired, should be stated in the specification. For very cheap work, rim locks are suitable. For the best work, mortised locks should be used. The greater the number of wards in the lock, the greater is the security.

182. Door Checks and Bumpers. — Where doors are used frequently and are liable to be left open, door checks should be used. These checks contain springs that force the door shut and oil or air cushions that take the impact and allow the door to close gently. Door bumpers of wood or metal with rubber tips are usually placed behind doors to prevent the doors from bumping the skirting.

183. Door Knobs and Hinges. — Door knobs are made of glass, china, wood, and metal, and are usually flattened spheres or ovals. Mahogany doors are often fitted with cut-glass knobs, which present a very rich appearance. Double-acting door hinges are used for doors in corridors between pantry and dining-room or pantry and hall, etc. These doors should have push plates, and should be fitted with hooks and eyes to fasten them open if necessary. Some hinges are made to remain open when at an angle of 90°. Butt hinges should have swing enough so that the door will clear the finishings when wide open, and the number of hinges should be sufficient to carry the door. Doors over 7 feet high or 4 feet wide should have three hinges. The loose-pin hinge is preferable to the fast-joint hinge, and should have not fewer than five knuckles. Door hangers with track for sliding doors are made in a number of types, and care should be taken in making a selection. Noiselessness, strength, and adjustability are points to be considered ; those fitted with ball bearings are the best for most purposes.

184. Strike Plates. — Where security is an essential point and stops are not housed into the jamb, a protected lock-strike should be used. This strike plate has a projection that covers the crack between the wooden stop and the jamb, through which a knife blade or a thin paper cutter may be thrust to throw back the latch. The rabbeting of the stop into the jamb, of course, obviates the necessity for the use of such a strike.

185. Kicking Plates.—Kicking plates should be placed on swinging doors in public dining-rooms between corridors and the dining-room.

186. Shutter Hinges. — Butt hinges for outside shutters should have swing enough, so that the blind may be thrown back against the building and fastened in that position. An adjuster is now made by means of which the shutters may be opened or shut from the inside of a room without opening the window.

NAILS AND SCREWS

187. Nails.—Nails are classified according to their method of manufacture as wrought, pressed, cut, cast, and wire nails; they are also classified by their lengths. Wrought nails are rarely used. . Nails are made from 1 to 6 inches long, and are usually sold by weight. The old system of selling by the hundred has been abandoned. Under it, $2\frac{3}{4}$-inch nails were called tenpenny; that is, 10d. per 100 nails, and so on. Copper, zinc, and composition nails are also made, and are used for slating in wet positions and in places where iron will not be suitable because of its magnetic action.

188. Screws.—Screws are made of iron, steel, copper, bronze, brass, and phosphor bronze. The ordinary screw is of iron, and may be electroplated to match the rest of the ironmongery, and have round, oval, or flat heads. For finished woodwork, where expense will allow it, screws are to be preferred to nails. Hand-rail screws are used to fasten together different parts of stair hand rails. They are threaded at both ends, and have a square nut at one end and a notch-edged nut at the other. The latter nut is used to tighten up the bolt through a hole in the rail after the bolt is in place.

189. Expansion Bolts.—Expansion bolts are made of iron, brass, and bronze, in many different patterns, and are used to fasten wood or other work to brick or stone. They consist of a bolt having either a screw or bolt head, which screws into a shell divided longitudinally into parts that spread as the bolt advances, thus causing the shell to grip the sides of the hole.

SLATER AND TILER

190. Uses and Sizes of Slate. — Slate is very largely used for covering roofs, wall surfaces, and for urinal partitions and backs, shelving, cisterns, skirtings, etc. Red, green, and grey slates are obtainable in a great variety of shades, quality, and size. With the exception of Westmoreland slates and other similar varieties, slates may be obtained in the various stock sizes and are generally sold by number, not by weight, that is, by the *mil*, or 1,200 slates for every thousand. The sizes in general use, together with the gauge, allowing for a 3-inch lap,

and the number of squares, 100 square feet, of roof surface that a mil of 1,200 slates will cover, are given in Table IV. An additional allowance must be made for waste due to cutting, which will vary considerably in accordance with the form of the roof. In some districts, the sizes of slates of the same names as those given in Table IV may vary slightly, so that, if extreme accuracy is necessary, the dimensions should be quoted when ordering. The gauge values given in Table IV are calculated for slates nailed near the centre.

TABLE IV

SQUARES COVERED BY SLATING

Name	Size Inches	Gauge Inches	Squares Covered by 1 Mil
Doubles	12 × 8	$4\frac{1}{2}$	2·9
Ladies	14 × 12	$5\frac{1}{2}$	5·3
Ladies (large)	16 × 8	$6\frac{1}{2}$	4·2
Viscountess	18 × 10	$7\frac{1}{2}$	6·0
Countess	20 × 10	$8\frac{1}{2}$	6·8
Marchioness	22 × 12	$9\frac{1}{2}$	9·1
Duchess	24 × 12	$10\frac{1}{2}$	10·0

191. Slate Roofing.—In good work, each slate is double-nailed, and generally laid with a lap of 3 inches.

192. Slate Testing.—To test a slate, place it on edge in water; if after 12 hours the water has not risen more than $\frac{1}{8}$ inch, the slate may be accepted without doubt, for it is practically non-absorbent. Good slate is not greasy to the touch.

193. Roofing Tiles.—Roofing tiles are sometimes bedded in lime-and-hair mortar and should be fastened in place with composition, zinc, or copper nails, or with copper wire. Roof boarding should be used under the tiling and covered with a good inodorous felt, unless the tile is very tight fitting, so that there is no danger of draughts under them. If the roofs are boarded, the bedding in lime mortar is not required.

There are many types of roofing tile on the market; they are generally made in reds and browns, but other colours can be obtained as desired. The effect of a single tile gives little idea as to how the finished roof will appear, so it is well to see the tiles laid in masses on roofs before deciding on the type to use. In calculating the weight of tiles for a roof, 10 per cent. should be added for the weight of absorbed moisture. Purpose-made valley and hip tiles are also made. It is considered better from the point of view of appearance in the finished work and the requirements of good construction that ridge and hip tiles be of a steeper pitch than the roof on which they are to be fixed.

194. Cleaning Out Gutters.—All gutters should be cleaned out, and all broken tiles or slates replaced, before the work is taken off the contractor's hands.

SHEET-METAL WORKER

195. Metals Used for Sheet-Metal Work.—The sheet metals used comprise lead, zinc, copper, and galvanized and corrugated iron; tin is used in America and the Colonies. Tin plate is sheet steel or iron coated with tin, and is used principally for fireproofing doors. Terne plate is sheet steel coated with a mixture of lead and tin in about the proportion of 1 of tin to 2 of lead; it is cheaper than tin plate.

196. Standards of Copper Roofing.—The size of British common plates is 48 inches by 24 inches, but Scotch plates are 48 inches by 42 inches. For roofing work, however, special sheets from 5 to 8 feet in length and 3 feet in width are generally used. Sheet copper for roofing is annealed, and is thus comparatively soft and capable of being bent without risk of cracking. The gauge, weight per superficial foot, and weight per plate of copper used for roofing purposes are given in Table V.

TABLE V

GAUGE AND WEIGHT OF SHEET COPPER

Birmingham Wire Gauge Number	Weight Per Superficial Foot		Weight of Common Plates		Weight of Scotch Plates	
	Pounds	Ounces	Pounds	Ounces	Pounds	Ounces
18	2	4	18	0	31	8
20	1	12	14	0	24	8
22	1	6	11	0	19	4
24	1	0	8	0	14	0
26		13	6	8	11	6
28		10	5	0	8	12
30		8	4	0	7	0

Copper roofs are probably best laid with roll, cleat, or standing seam, unless flat, when a lap seam soldered and fastened with cleats is best. In all these cases, the expansion and contraction of this metal should be kept in mind and provided for by using double-locked seams, clips, etc. Copper is probably the best material available for roofing purposes on account of its toughness and durability; No. 24 B.W.G. is the size usually specified for covering roofs. Sal ammoniac is used as a flux for copper soldering, and half-and-half for solder.

197. Black, Galvanized, and Russia Iron.—Iron and steel in the form of sheets, called sheet iron and sheet steel, respectively, can be obtained cold rolled and hard, or annealed and soft; either kind can be

had in the natural state, when it is called black; or coated with zinc, when it is called galvanized. Sheet iron is designated by its thickness as measured by a wire gauge, and is used in some situations for roofing purposes. Since different gauges are used by different manufacturers, and as the thickness of the sheet stamped with the same gauge number varies with the manufacturer, it is advisable to specify the weight per square foot, or the thickness in thousandths of an inch, so that there shall be no mistake on the part of the manufacturer in despatching the ordered goods correctly. Russia iron is a variety of sheet iron having a surface specially prepared to resist corrosion by a covering of flexible transparent enamel. Genuine Russia iron is made in Russia, but British- and American-made Russia iron, fully as good, can now be obtained.

198. Sheet Zinc.—Zinc is largely used for a cheap class of roofing; it expands and contracts more than any other roofing metal. Pure sheet zinc, if properly laid, makes a very durable roof. Sheet zinc is made in sheets that weigh from 11·44 to 30·69 ounces per foot, and is usually graded by the Vieille-Montagne zinc gauge; No. 15, weighing 21·75 ounces per square foot, is the size usually specified for roofs; and No. 16, 24·75 ounces per square foot, for gutters.

The methods of laying zinc roofing are similar to those used for copper. Paper should be laid under zinc, as it is very susceptible to wood acids. No other metals should be used in connection with zinc because of the liability to chemical action and the great amount of difference in expansion and contraction of the different metals. Zinc nails should be used. Work tables for kitchens are often covered with sheet zinc or block tin. Zinc gutters are also made in sizes from 2 to 6 inches.

199. Lead.—Sheet lead may be obtained in sheets that are from ·017 to ·203 inch thick and weigh from 1 to 12 pounds per foot. It is usually designated by weight per foot, and is used principally for roofing, gutters, flashings, and lining cisterns.

TABLE VI

WEIGHTS OF LEAD FOR VARIOUS POSITIONS

Position	Weight Per Square Foot Pounds
Main gutters	7 to 8
Flats	6 to 8
Hips, valleys, and ridges	6
Flashings and aprons	5
Soakers	4

The weights of lead for different situations are given in Table VI. They vary in accordance with the extent of wear or exposure to which a roof is likely to be subjected. Lead used in gutters and flats, for instance, is subjected to much more severe wear than lead used for flashings.

200. Lead Roofing.—Roofs covered with sheet lead should not have a pitch of less than 2 inches in 10 feet, and the boarding on which it is laid should be matched, running with the fall, and blind-nailed. Expansion and contraction should be provided for by forming rolls, about 2′ 5″ centres, and sufficiently close to allow the overlead to cover them completely, and lie about 2 inches flat on the other side. Lead flats are usually made of 7-pound lead. Drips should be 2 or $2\frac{1}{2}$ inches deep.

201. Canvas Roofing.—In the Colonies and America, canvas is sometimes used to cover balcony or porch roofs that are to be used as upper porches. None but the heaviest quality of canvas should be employed for this purpose. When placed on matched sheathing, the canvas should be laid in pine pitch ; but if placed over a tin roof, it should be laid in a thick coat of white lead. All seams in the canvas should be double-sewed, and, if nails are used, they should be of copper. After the roof is laid, the canvas should be thoroughly soaked with pure linseed oil, and then given two or three coats of white lead and oil.

202. Flashings.—Counterflashings and aprons should be of sheet lead or copper, rather than of zinc. Flashings are usually made of 5- to 8-pound lead and aprons of 5-pound lead.

203. Counterflashing for Asphalt Roofs. — The counterflashing for asphalt roofing should be of lead, which is applied the same as for other roofs.

204. Gutters. — Gutters may be *hanging*, *box*, *roof*, or *parapet*. Hanging gutters are always preferable where it is possible to use them ; they can be made of iron or zinc. Roof or box gutters may be of lead, zinc, or copper, and should be large in size and have ample pitch. The pitch of gutters should not be less than 1 inch in 10 feet. Wire baskets, which are used to protect down-spout openings in gutters, should, for the best work, be made of copper wire. Gutters against parapets, high walls, walls, etc., should turn up 5 to 7 inches, and be covered with an apron of about the same width ragleted into the wall. Valley gutters should turn up under the slates 7 to 9 inches, according to the slope of the roof. Gutters in good work are made of 7- to 8-pound lead.

205. Ornamental Gutters. — Ornamental gutters are made in a great variety of designs. They are usually screwed or bolted to a wooden plate fixed to the toe of the rafters, and should be thoroughly painted on both sides. Iron hangers used for half-round gutters should have two good coats of iron-oxide paint. Copper gutters are occasionally used, and do not require painting, as the patina that forms on the copper is sufficient protection. Ornamental gutters are often formed with a milled or imitation tooled surface, which, after being painted, is sprinkled evenly with white sand while the paint is still wet. When dry, this makes a fair imitation of stonework.

206. Hangers for Gutters.—Stock hangers are made, by means of which hanging gutters are fastened in place. Wrought-iron brackets that support the gutter from below and also serve as a decorative feature are sometimes used.

207. Rain-Water Down Pipes.—Iron or lead down pipes should be 1 square inch in section for each 200 to 250 square feet of roof area drained. No down pipe with an area less than that of a 2-inch round pipe should be used. Down pipes are sometimes fastened by expansion bolts or patent hangers, but more often with ordinary rain-water pipe nails. Sometimes, however, decorative straps in connection with expansion bolts or screws are used to support down pipes, but more frequently these straps simply cover the hanger or other means of support.

208. Rain-Water Heads.—Rain-water heads are often used at the tops of down pipes and cover the bends that issue from cornices. The tops of these heads should be covered so as to prevent birds from building nests in them. Stock designs are made by some manufacturers. Special designs are more acceptable, but are more costly.

209. Solder Dots.—Solder dots on a copper cornice should be copper-plated in order that they may not show on the surface after the patina has formed, or else all joints should be riveted with copper rivets.

210. Fire-Doors and Fire-Shutters.—Fire-doors and fire-shutters are made of wood covered with sheet tin, no solder being used for seams; asbestos cloth, however, should be placed between the wood and the metal. A door is now made of sheet steel without the wooden core, the stiles and rails only being reinforced with a small amount of cork or similar material.

211. Other Sheet-Metal Products.—Imitation tiles, bricks, etc., are now made in copper, tin, and galvanized iron. Work of this kind in tin and galvanized iron should be thoroughly painted on both sides. Coping coverings, chimney caps, balustrades, outside light standards, candelabra, flagpole bases, etc., are made of copper and galvanized iron.

HEATING AND VENTILATING ENGINEER

STEAM AND HOT WATER

212. Boilers.—Steam and hot-water boilers are made in many varieties; the best types are made in sections, the number of which determines the boiler capacity. Boiler catalogues usually give for each boiler the number of sections, the length and the height, the size of the grate, the capacity of the firebox, the size of the steam and return-main

outlets, and the amount of radiation that it is calculated to supply. The selection of a type of boiler should be made with great care. If possible, different makes of good reputation in actual use should be looked over and their efficiency thoroughly investigated. The boiler should be set on a concrete foundation, and the outer surface of it should be covered with an asbestos cement to the thickness of $1\frac{1}{2}$ to 2 inches; this cement is applied in three coats while the heater is under fire. The final coat should be rubbed smooth with a piece of wet rubber, after which the entire surface should be covered with a 6-ounce canvas put on with good flour paste.

213. Piping.—The pipes of a steam system should be run in such a manner that the supply of steam will be evenly distributed to all parts of the building. When the piping is completed and tested, the distribution of steam should be carefully noted, and if it is necessary to run an extra feeder to any point, it should be done. This extra piping should be provided for in the specification. Care should be taken to have piping large enough and properly pitched.

Where water is liable to accumulate in the steam mains, drip pipes should be taken off the bottom of the main and connected to the return. This will relieve the system of water that would otherwise interfere with the circulation of the steam.

The supply pipes to the hot-water radiators on the upper floors, where a two-pipe system is used throughout, may be smaller than the pipes for the same-sized radiators on the first, or lower, floor, because the higher the radiator, the greater will be the pulling force of the return circulation. For both steam and hot water they should be taken from the top of the main. The returns of the hot-water radiators should connect into the side or the bottom of the main; the steam returns should connect into the top.

Branches leaving the steam main at an angle should have a pitch of 45°, and should be of one size larger pipe than the riser, reducing fittings being used for connections.

214. Pipe Covering.—Where a boiler is used, the steam main and returns should be covered with sectional covering. This covering reduces the amount of condensation and keeps the temperature of the water in the returns higher than would be the case without the covering. Where the condensation is drained to a sewer, it is not necessary that the return lines should be covered.

215. Pipe Defects.—It is important that the full area of the pipes be obtained, and for this reason all pipe should be cleared of burrs, dirt, scale, etc.

216. Supports. — Expansion and contraction of hot-water and steam-pipe lines should be provided for by using proper expansion hangers and supports for both the piping and the radiators.

217. Protecting Piping and Woodwork.—Ceiling and floor plates should be placed about the piping where it passes through floors and ceilings; and where the piping passes through wooden walls, metal sleeves with ample clearance should also be used, in order to protect the woodwork and to facilitate the removal of the piping for repairs, etc. All steam and hot-water pipes should be painted or bronzed where exposed; but, where possible, these pipes should be hidden from view.

218. Fittings and Unions.—Long-turn fittings should be used in hot-water systems, as they greatly aid the circulation. The common screw union should never be used in hot-water piping; the right-and-left coupling should always be employed instead. The flanged unions should be employed for large pipes.

219. Valves.—**Gate valves** should be used in a hot-water system, as they offer less resistance to the circulation than a globe valve. Valves larger than $2\frac{1}{2}$ inches should be iron-bodied and brass-mounted; smaller valves may be brass throughout. Stop-valves should never be placed on the line between the boiler and the expansion tank of a hot-water system; the expansion tank should also be protected from freezing.

220. Vents.—Air vents should be placed on the return lines in the two-pipe steam system, so as to get rid of any air that may accumulate. Vents should also be placed on the hot-water system at the proper points, which should be stated in the specification.

221. Radiator Connections.—Hot-water radiators cannot be successfully operated with a single connection; they should have two connections, one for the inlet and the other for the outlet. The supply pipe may enter the top or bottom of the radiator, but the outlet should always connect at the bottom.

222. Repairing Leaks.—As soon as the work of installing a heating system is completed, steam or water, as the case may be, should be turned into it, and if any leaks are discovered, they should be repaired immediately. The contractor should be required by the specification to agree to make repairs free of charge for one winter following the completion of same, where such repairs are necessitated by defective workmanship or material.

223. Radiation.—In buildings heated by steam or hot-water systems, the term *radiation* is used to designate the surfaces used for heating purposes, and these may be either *direct*, *indirect*, or *direct-indirect*. The amount of radiation is usually governed by the number of sections, or coils, in the radiators, which are made in a great many styles and in several forms for special use. Each radiator should be supplied with an air valve that will allow the air to escape, but will close when the steam reaches it. The valves controlling the supply and return pipes

should have wooden or hard-rubber handles to protect the hands from the heat. In bathrooms, narrow halls where space is valuable, or basements where the radiators must be high enough to give flow for the condensation back to the boiler, wall radiators should be used. As a rule, radiators should be placed on outside walls, under or near exposed windows, where they will warm the cold air that may enter through the cracks. The ordinary type of radiator can generally be used for both water and steam, but as this is not always the case, careful investigation should be made before specifying any particular kind. The specification should give a list of the different radiators, with the amount of heating surface and the height in each case. It should also state the style and the number of sections and the method in which the exterior of the radiators is to be finished, either with ordinary paint, or any special finish required.

224. Direct Radiation.—In direct radiation, the air is heated by a radiator placed in the room. The different forms of direct radiation may be classed as ordinary, window, wall, corner, dining-room, and built-up pipe or coil radiation.

225. Indirect Radiation.—The radiators for indirect radiation are usually placed in the basement, and are encased in galvanized-iron boxes, which are connected to the outside atmosphere and to the registers by ducts also made of galvanized iron. By this arrangement, the rooms are supplied with heated fresh air. Indirect radiation is more expensive than direct radiation, but is considered more healthful.

226. Direct-Indirect Radiation.—The radiator used for direct-indirect radiation is placed in a manner similar to those used in direct radiation, but has a specially constructed base, which is enclosed and connected by a small duct to a register in the outside of the wall. It also has a register in the base, which opens into the room. When the inner register is closed, the outer one is open, allowing fresh air to enter and pass up between the sections of the radiator, thus making it an indirect type of radiator. When the inner valve is open the outer one is closed, and the radiator becomes direct.

227. Plate-Warming Cupboards.—Plate-warming cupboards are often placed in the butler's pantry or elsewhere, and are a great convenience to the housewife. They consist of a cupboard lined with tin, copper, or galvanized iron, and have shelves made of coils on which perforated sheets of galvanized iron are placed.

228. Future Extensions.—Where additions to the system may be required at some future time, the piping should be proportioned accordingly, and plugged tees placed where the future branches may be needed, so as to avoid the taking down of a considerable length of piping when a new branch is required, or an extension has to be made.

VENTILATION

229. Ventilating Systems. — The ventilation of the ordinary residence is sufficiently taken care of by fireplaces and cracks at doors and windows, but for schoolhouses, asylums, and buildings where many persons are in the rooms and the consumption of oxygen is large, some method of artificial ventilation is needed. The usual methods may be classed under two main headings, the *vacuum* and the *plenum systems*, or they are combinations of these two.

230. Vacuum System.—In the vacuum method the air is exhausted from the different rooms by means of a fan or heated-air column, thus causing a suction and making room for the entering heated air.

231. Plenum System.—The plenum method is usually combined with the heating system, the air being forced over heating coils and into ducts leading to the various rooms, thus displacing the foul air, which is either drawn out by a fan, a heated-air column, or by the natural rising of the hot air, as in theatres and lecture halls, where the air escapes at the centre of the ceiling. In theatres, the rise of the air is often assisted by a group of lights in the central chandelier.

232. Vents. — Vent registers at the floor should be low and wide. If ceiling vents are used, they should never be placed directly over the hot-air register, as it will cause the hot air to short-circuit and thus leave the balance of the room unsupplied. In this case, the vent and hot-air registers should be on opposite sides of the room. Placing vent registers at both the floor and the ceiling of a room and on the side opposite the hot-air registers is a good arrangement, as it gives ventilation to both the upper and the lower parts of the room.

233. Schoolhouse Ventilation. — Schoolhouses heated by an indirect plenum system should have a certain amount of direct radiation to take care of the rooms when the fan is stopped; but, if possible, the ventilation should be so arranged that, when the fan is not in use, suction will be furnished by natural ventilation to make the rooms reasonably warm without the use of the direct radiation.

234. Ventilation and Heating Plans. — Plans of each floor and basement should be made that show the position of the radiators, direct and indirect, and the registers; the direction and sizes of the steam or hot-water piping and the galvanized-iron ducts; and the position of the fans, heaters, etc. These plans should supplement the specification. When the ventilation and heating scheme for a building is placed in the hands of a heating engineer, the architect usually supplies him with a set of tracings, or blueprints of the plans, on which he can work out his complete scheme, and show the positions of his boilers and radiators and the run of his pipes.

PLUMBER

235. General Remarks. — The excavator or labourer is usually required to do all the excavating necessary for water, gas, and sewer connections. The plumber's work usually comprises the supplying and placing of the iron soil pipes with their necessary vent stacks, the tapping of the water mains, and the running of the supplies and branches to the various fittings and taps. The nearest point at which mains may be tapped should be ascertained by the architect, and these points should be specified and plainly shown on the drawings. If sewage is to be discharged into a cesspool, it should be shown on the drawings, with the level of the inlet indicated.

236. Important Considerations in Piping.—The freezing of water in pipes should be carefully guarded against, and, for this reason, as much of the piping as possible should be run in the warm parts of the building. Where exposed, in the best work, the piping should be protected with hair felt, mineral wool, or some other non-conducting materials. Where the water pressure is heavy, the supply pipes should be extended a short distance beyond the taps. This forms an air cushion that takes up some of the shock due to shutting water off suddenly, thus saving the strain on joints, etc.

237. Water Pipes.—The supply pipes from street mains should be from 1 inch to 6 inches in diameter, the former size being suitable for

TABLE VII

SIZES OF COLD-WATER BRANCHES TO POINTS

Supply Branches to	Diameter, in Inches		Supply Branches to	Diameter, in Inches	
	Low Pressure*	High Pressure*		Low Pressure*	High Pressure*
Bath	$\frac{3}{4}$ to $1\frac{1}{4}$	$\frac{3}{4}$ to 1	Sitz or foot-bath	$\frac{1}{2}$ to $\frac{3}{4}$	$\frac{1}{2}$
Lavatory	$\frac{1}{2}$ to $\frac{3}{4}$	$\frac{1}{2}$	Kitchen sink	$\frac{1}{2}$ to $\frac{3}{4}$	$\frac{1}{2}$
Water-closet flush tank	$\frac{1}{2}$ to $\frac{3}{4}$	$\frac{1}{2}$	Pantry sink	$\frac{1}{2}$ to $\frac{3}{4}$	$\frac{1}{2}$
			Slop sink	$\frac{1}{2}$ to $\frac{3}{4}$	$\frac{1}{2}$
Water-closet flush valve	1 to $1\frac{1}{4}$	$\frac{3}{4}$ to 1	Urinal	$\frac{1}{2}$ to $\frac{3}{4}$	$\frac{1}{2}$

* High water pressure is any pressure above 25 pounds per square inch; low pressure is any pressure below 25 pounds.

small residences and the latter for large public buildings. For very high pressures, pressure regulators are placed on the supply pipes just inside the basement walls. The branch pipes to the different fittings should be

of the sizes shown in Table VII. These pipes should be exposed to view and supported by neat hangers on wooden blocks. They should also be tagged where leaving the main, so as to indicate the fittings that they supply.

238. Lead and black or galvanized wrought-iron pipes are used for the cold-water supply, and galvanized-iron and copper pipes for hot-water supply. Lead pipe, however, is preferable for cold water unless the character of the water is such that it acts as a solvent on the lead. The durability of galvanized iron depends entirely on the thickness of the coating on the interior of the pipe. Copper pipes are best for hot-water supply. Where lead pipe is used, it should be supported on shelves or some similar arrangement to prevent sags, which form pockets for sediment, etc. The weights of lead pipe should be the same as given in Table VIII, but the water companies have nearly all different regulations regarding the weight of piping to be used. These regulations should be obtained before specifying.

TABLE VIII

WEIGHT OF LEAD PIPE

Diameter of Pipe Inches	Weight Per Linear Yard Pounds
2	24
$1\frac{1}{2}$	18
$1\frac{1}{4}$	14
1	12
$\frac{3}{4}$	9
$\frac{1}{2}$	6

239. Cast-Iron Pipes.—Cast-iron pipes are plain or are coated with some material, such as Dr. Angus Smith's solution, or galvanized, to protect them from rust. Pipes which are not protected from rust are not to be

TABLE IX

APPROXIMATE WEIGHT OF CAST-IRON SOCKETED SOIL AND WASTE PIPES

Internal Diameter Inches	Pounds Per 6-Foot Length				London County Council Pounds	Extra Heavy Pounds
	Medium		Heavy			
$1\frac{1}{2}$				27		
2	24			34	25	
$2\frac{1}{2}$	26	28	38	40	33	60
3	34	36	46	48	40	76
$3\frac{1}{2}$	38	40	52	54	48	90
4	44	46	58	60	54	100
$4\frac{1}{2}$	52	54	68	70		
5	58	60		80	69	
6	82			98	84	150

recommended. Whether they are to be used as drain pipes, soil or waste pipes, or water pipes, all cast-iron pipes should be true in section, free from surface defects which would impede the flow, straight, and with good-fitting spigots and sockets. The weights of soil and waste pipes are given in Table IX; water pipes are a little heavier.

240. Brass and Copper Pipes.—Whenever brass or copper pipes are used for conveying water for drinking or cooking purposes, they should always be tinned inside, otherwise the water may be seriously poisoned. The weights and thicknesses of these pipes are given in Table X.

TABLE X

SEAMLESS-DRAWN BRASS AND COPPER TUBES, IRON-PIPE SIZE

Size (Nominal) Inches	Outside Diameter Inches	Thickness Standard Wire Gauge	Weight Per Linear Foot	
			Brass Pounds	Copper Pounds
$\frac{1}{8}$	$\frac{3}{8}$	10	·39	·37
$\frac{1}{4}$	$\frac{1}{2}$	10	·58	·54
$\frac{3}{8}$	$\frac{5}{8}$	10	·78	·72
$\frac{1}{2}$	$\frac{13}{16}$	8	1·28	1·20
$\frac{3}{4}$	$1\frac{1}{16}$	8	1·76	1·62
1	$1\frac{5}{16}$	8	2·24	2·12
$1\frac{1}{4}$	$1\frac{5}{8}$	6	3·35	3
$1\frac{1}{2}$	$1\frac{7}{8}$	6	3·93	3·75
2	$2\frac{3}{8}$	6	5·09	4·88
$2\frac{1}{2}$	3	3	8·39	8·20
3	$3\frac{1}{2}$	3	9·91	9·70
4	$4\frac{1}{2}$	3	12·96	12·70

241. Water Supply.—If the water supply for a building is to be furnished by a cistern placed in the attic, the water may be drawn from the water company's mains direct, or it may be taken from the mains, if the pressure is insufficient to raise it, a lake, a stream, or some other such source, and be raised to the tanks by means of a hand, hot-air, steam, or electric pump, or a windmill or hydraulic ram. Many of the water companies' by-laws insist on each house being provided with a cistern. Before specifying, the architect should inform himself of this. Water-storage tanks are always used in very high buildings supplied by town mains that have insufficient pressure to force the water supply to the top stories during the day. These tanks are placed on the roofs or in the top stories of the buildings, and are filled at night when the water pressure is greater, owing to the fact that less water is being used.

242. Water Cisterns and Tanks.—The cisterns used for water supply, if not large, are made of $1\frac{1}{2}$-inch material built rectangular in shape and dovetailed at the corners, and lined with copper, lead, or galvanized iron. Galvanized-iron tanks are made by many manufacturers and are specially adapted for cisterns of large capacity. Precautions against freezing should be taken, and the tank should be covered and ventilation supplied. A lead safe with a pipe delivering into a sink in the lower part of the house is sometimes placed underneath the tank. The supply pipe should be taken from the side of the tank and not from the bottom, in order that sediment may not be pulled into the supply system. A draw-off pipe with trumpet-mouth standing waste should be taken off the bottom and run into a bath or large sink, and should not be connected directly to the drainage system. Each cistern should be provided with valves for shutting off water, hot and cold supply, with copper air pipes, also with iron ball valves and strong copper wire, engraved index plates, etc. The ball-cocks should be made of strong copper.

243. Cocks and Valves.—A stop-and-waste cock should be placed on the water-supply pipe just inside where it enters the building. All piping should drain toward this cock in order that the entire system may be drained at this point. Each supply branch should have a valve between the main and the fitting that will allow the fitting to be cut off for repairs. Such an arrangement will avoid shutting off the water from the entire building, which would be necessary if no such valves were placed.

244. Filters.—If the water supply is constantly muddy or contains much foreign matter, filters should be employed, as such sediment is not only dangerous to health and disagreeable, but is also liable to clog boilers, etc.

245. Circulating Hot-Water System.—The quick delivery of hot water to bathrooms and lavatories remote from the heater may be accomplished by a circulating system, or loop of pipe, which includes in its circuit the boiler and hot-water tank. A relief pipe of small diameter with an air valve should be placed at the top of the loop, and, where necessary to compel the taking of hot water from the loop in the direction of the circulation, check-valves should be placed on the line. This loop may include a hot-water radiator, which could be used to heat a room over the kitchen or elsewhere.

246. Soil Stacks.—The soil pipe, or stack, is the vertical cast-iron pipe that takes the waste from water-closets, basins, tubs, etc. This pipe should be extended at least 2 feet above the roof and kept as far away from dormer windows or other openings as possible. The top should be left open, with copper-wire guard. Water-closets should have separate soil pipes from lavatories, sinks, etc. The main soil stack should not be

less than 4 inches in diameter, as it not only serves as a waste, but also as a vent pipe. Branch vents and other smaller vent stacks may be connected to this stack above the highest fitting. The soil stacks should be well supported by wrought-iron straps or holdfasts at the joints. This is often neglected, but is of great importance, as a slight settlement in the stack will open the joints between the branches and the stack. Four-inch cast-iron pipe weighs about 55 pounds per 6-foot length, so that, where a stack is 30 feet or more in height, the weight at the base is considerable.

247. Soil- and Vent-Stack Sizes.—The size of soil and vent stacks with relation to the number of fittings should be as given in Table XI.

248. Size of Branches. All the vent branches from traps to stacks should be of about the same sizes as the wastes from fittings. No pipe less than $1\frac{1}{2}$ inches in diameter should be used, and for slop sinks and closets, 2-inch pipe is suitable.

TABLE XI

SIZE OF SOIL AND VENT STACKS

Diameter of Soil Stack Inches	Diameter of Vent Stack Inches	Number of Fittings
4	$2\frac{1}{2}$	1 to 15
5	3	16 to 30
6	3	31 to 50
7	4	51 to 80
8	4	81 to 120
9	$4\frac{1}{2}$	121 to 200
10	5	201 to 300

249. Traps.—Pot, or grease, traps are suitable for baths or sinks, where there is likely to be considerable grease, hair, etc. These traps should be made accessible for cleaning, as they are very liable to be forgotten. Ball traps should be used where the fitting to which it is connected is not likely to be used for long periods. Different forms of traps are in use in various districts. As few traps should be used as possible, but all should have screw clean-outs, so that they may be cleaned from time to time.

The trap should be placed as close to the fitting as possible, so that the outlet pipe between the fitting and the trap that is unvented may be as short as possible. This is specially important in the case of urinals.

250. Fittings.—The fittings are selected and specified from manufacturers' catalogues by the number of the plate and the quality. They include baths and showers, basins, water-closets, sinks, laundry tubs, urinals, etc. Baths are in two shapes, the ordinary and the Roman, the former being preferable. The porcelain-enamelled iron or painted bath and the solid porcelain bath are the best, and are also the cheapest in the end. The showers may be set over the baths, over separate pans, or over cement floors drained to the sewer. Wash basins are round or oval, and are sometimes set in moulded marble slabs; the oval bowl is the better.

The simplest and best basin for ordinary use is cast in one piece, and is supported on iron brackets, with all waste and other pipes exposed to view. Water-closets are made in many types ; the pan closet should never be used. Pedestal wash-down closets are most suitable for ordinary work. They should be supplied with an ample flush of water, at least 2 gallons. All flushing cisterns should be made so as to flush *silent*. Wash-out closets should not be used. Water-closets should be placed in rooms with outside windows or proper ventilation.

251. Sinks.—There are kitchen, pantry, and slop sinks. Kitchen sinks are made of solid porcelain, fireclay, iron porcelain-enamelled, slate, and plain or galvanized cast iron. For good work, the solid porcelain or fireclay sinks are used ; for cheaper work, the galvanized-iron or enamelled sinks are used. Pantry sinks are made of solid porcelain, fireclay, enamelled iron, copper, lead, and teak. These are all good ; the first two materials are the best as well as the most expensive. Wooden or rubber mats should be used in the bottoms of pantry sinks to prevent the breakage of fine china or the enamel of the sink. Slop sinks are made of porcelain, enamelled iron, and earthenware.

252. Laundry Tubs.—Laundry tubs are made of porcelain, earthenware, enamelled iron, slate, cement, and wood. Wooden tubs should never be used ; the other types of tubs are desirable in the order in which they are named.

253. Urinals.—Urinals are usually in the form of a trapped bowl or gutter ; the former is made of earthenware or iron and the latter generally of iron. The gutter form of urinals is used in public places or buildings.

254. Stop-Cocks.—The stop-cocks that supply the different fittings should be specified clearly. In public places where they are likely to be left open, the stop-cocks should be of the self-closing type. In the best class of work, the exposed metal work of all fittings is usually nickel-plated ; but sometimes the stop-cocks are of plain brass and the traps and piping of lead or iron painted with an oil paint. Explicit statements as to these matters should be made in specifying each fitting.

255. Connections.—The method of making connection between the lead bend and the base of the water-closet should be carefully considered, as it is a difficult joint to make. There are several very good patents on the market for this. After *roughing in* is done, all openings of closet bends, vent pipes, etc., should be securely closed, to prevent clogging with sticks, rags, etc.

256. Tests.—Before they are covered, all plumber's sanitary work should be tested by the water or smoke test ; and again after the whole work is completed.

257. Plans and Drawings.—Plans should be made of each floor, showing the position of the different fittings and the drainage and vent pipes. Sections should also be made showing the traps, stacks, etc. The sanitary laws of the larger towns are complete and exacting, and it is well to make them a part of the plumbing specification by stating that the work is to conform to them and stand the tests required by the local sanitary inspector.

GAS-FITTER

258. Gas Mains.—The gas mains should be pitched to a low point near the meter, with a stop-and-waste cock to drain from the system the water of condensation that may accumulate. The pipe should be of standard wrought iron or steel for the mains or where exposed on the surface of the plaster. Composition pipe may be used inside buildings and where there is no chance of its being pierced with nails.

259. Branch Pipes.—The branches to the outlets should be risers where it is possible, and trapping should be avoided. The proper sizes of branch pipes for coal and gasoline gas are given in Table XII. In the best practice, no pipe smaller than $\frac{3}{8}$ inch is used for coal gas.

TABLE XII

CAPACITY OF WROUGHT-IRON GAS PIPES

Diameter of Pipe Inches	Maximum Length Feet	Capacity Per Hour	
		Coal Gas Cubic Feet	Gasoline Gas Cubic Feet
$\frac{1}{4}$	6	10	
$\frac{3}{8}$	20	15	10
$\frac{1}{2}$	30	30	20
$\frac{5}{8}$	40	60	40
$\frac{3}{4}$	50	100	75
1	70	175	125
$1\frac{1}{4}$	100	300	200
$1\frac{1}{2}$	150	500	350
2	200	1,000	700

260. Fittings. — The fittings, such as knees, bends, etc., for gas piping should be of malleable galvanized iron. The beaded fittings are preferable to the plain, as they are stronger and present a better appearance. Gas fittings are made in wrought iron, brass, copper, or a combination of metals, in a great variety of designs. In the best work, fittings are often specially designed. A sum is usually allowed in specifications for fittings, these being selected either by the architect or owner.

The proper heights from the floor for gas brackets or side-wall lights are from 5 feet 6 inches to 6 feet. Pendants should be placed from 6 feet 6 inches to 7 feet from the floor. The positions of the brackets should be carefully considered with regard to the swing of doors,

fireplaces, etc., and lights should be placed for sinks and to properly light staircases, closets, etc.

261. Testing.—When completed and capped, the gas-piping system should be tested by forcing compressed air into the piping by means of a hand pump; the pressure of the compressed air should be registered by a pressure gauge or a water column. The pressure indicated by the gauge should be from $\frac{1}{2}$ to $\frac{3}{4}$ pound per square inch, and should be sustained for at least 1 hour. The water column should stand at a height of from 15 to 20 inches for a like period. In large buildings, it is customary to test the system in sections. Leaks are found after the pressure is applied to the system by putting soap suds on the joints of the fittings. The bubbles formed by the escaping air will show the position of the leaks.

262. Meters.—Connections are left at the proper point for the gas meter, which is furnished by the gas company and connected by them to the main and supply pipe. This meter should be supported on a wooden shelf at some accessible point in the basement. A separate meter is sometimes placed on a branch to the gas stove or heaters. This branch should, of course, be taken off the main on the outside of the regular meter.

263. Acetylene Gas.—Acetylene gas is suitable for country houses, and there are a number of companies who make reliable generators. Smaller pipes are used than for coal gas, and also a different type of burner. Copper should not be used in connection with acetylene gas, as the gas forms an explosive compound with it.

ELECTRIC WIRING

264. Setting Out Systems.—A wiring system should be so set out that neither the cost of electric energy nor the cost of the wiring shall be excessive. Copper wire is used almost exclusively for electric conductors, because it has low resistance and is easily soldered when splicing. The size of wires required depends on the quantity of current to be carried, the length of the wire, and the voltage at which the current is supplied. The proper size may be calculated or obtained from tables prepared for this purpose. All cables and wires are made to the standard wire gauge (S.W.G.), and all makers provide a list stating the sizes and number of strands of wire in each cable with the amount of current each cable will carry. The amount of resistance of a wire varies directly as its length and inversely as its size; the larger the wire, the less is the resistance.

265. Making Joints in Wiring.—In making joints in electric conductors, the insulating covering on the portion of the wires to be joined should be cut away and the wires scraped clean. They should then be

twisted together until the joint is mechanically and electrically secure, after which it should be well soldered to preserve the connection and then covered with insulating tape.

266. Methods of Wiring. — For the wiring of an old building, wooden moulding or casing can be placed directly on the plaster or woodwork and afterwards painted. All work of a better class is now done in iron conduits, concealed under the plaster. Wherever joints occur, proper junction boxes must be employed, as no joint is allowed inside a pipe. The backs of all switchboards and fuse boxes must be provided with iron boxes, and the whole system of piping must be securely screwed and connected together and carefully earthed to the nearest water main. The piping system should be completed before the plaster work is begun, and the cables and wires drawn into position after the plaster is dry. The openings about the wires should be plugged at the outlets and made as moisture-tight as possible with tar paint or some other suitable compound. The rules laid down by the fire insurance companies, and those of the particular company from whom current is to be obtained, must be followed by the electrical contractor; these rules should be made a part of all electrical specification.

267. Service Mains.—For large buildings where a heavy circuit is required, more than one service should be used.

268. Conduit Elbows.—The changes in direction of conduit work are made with bent conduits or by standard elbows. There should not be more than four elbows in any one run from the cut-out box to the switch or the cut-out box to the outlets, in order that the *fishing*, pulling the wire through the conduit, may be easily done.

269. Outlet Boxes. — Outlet boxes for conduit work are of two types, one where the box is made for a given position with a given number of outlets, and the other where the position and number of outlets are variable. In the latter type the sides are made with circular indentations, which may be knocked out with a hammer to make an outlet at the desired point.

270. Position of Wires and Conduits.—The wires and conduits in wooden partitions and floors are run between the joists and studding; on brick or stone walls, in chases or behind furring or strapping; and in fire-resisting construction, between floor arches and suspended ceilings, in chases of partitions, behind casings of columns, in shafts, and in wooden mouldings on the surface of the plaster. In fire-resisting buildings, the main conduits are usually run in a shaft from which the branches are taken through cut-out boxes at each floor.

271. Electric Meters.—The meter or meters for large buildings are usually placed on a panel in a separate closet or room, where they will

be accessible to no one except an authorized person. Every precaution should be taken to avoid fire resulting from blowing fuses. For residences of ordinary size the meter and main switch are usually placed in a convenient position, and are enclosed in a panel box fitted with a door, which should be kept locked. Electric-light companies usually furnish and erect their meters on panel boards provided for that purpose.

272. Mains.—Mains are run from the main switch to the various distributing boards from which the distribution circuits are run, to the lamps, etc. The mains and the branches are all fused, so that, if the current is raised above the safe carrying capacity of the branch, the fuses are melted, thus breaking the circuit.

273. Cut-Out Boxes.—The distributing centres are called *cut-out boxes*, and are required by the insurance companies' rules to be lined with marble, slate, or asbestos board, and otherwise made safe from fire. These boxes are often sunk into the wall, and are finished in a manner similar to the doors and windows. The doors should be glazed and fitted with locks, and all the woodwork used should be as dry as possible. The switches of the different circuits should be tagged, indicating the circuits they control.

274. Switches.—The switches that control the lights in a room are often grouped in one box with a plate to cover them all. The face plates should match the other ironmongery of the room. Where temporary current may be required for reading lamps, fans, etc., plugs are placed in the floor or the side wall. Connection to the fittings from these is made by means of flexible cord. A list of the different switches and wall plugs, with their positions and the lights they control, should be included in the specification, and three-way switches should be used where a group of lights are to be controlled by two switches at different points. The particular make of switch to be used should also be specified. The flush-type switch is the neatest.

275. Methods of Fastening Fittings.—Suitable means of support should be provided for the fittings, and the position of each fitting should be clearly indicated in the specification, or on the plans.

276. Approval of Wiring.—The contractor should be required by the specification to obtain a certificate of approval by having the authorized inspectors of the insurance company and lighting company look over the work, and to deliver the same to the architect on completion of the work, the acceptance of which should be made conditional on the delivery of this certificate. Lighting company inspectors test all work before consenting to supply current.

277. Electric Appliances.—Various electric appliances are at the disposal of the architect, among them being bells or buzzers, clocks

controlled by a master clock, door openers, burglar alarms, gas lighters, pumps, fans, storage batteries, temperature regulators or thermostats, and watchmen registers. Drawings are usually made showing the position of fittings, switches, boxes, meters, and main switches, and are supplementary to the specification.

278. Writing the Specification.—As electrical work is generally undertaken by a competent electrical engineer, who should act as a subcontractor to the general contractor, the specification for the work is often written by a consulting electrical engineer, who works in conjunction with the architect. This is especially the case in large and important work.

PLASTERER

INTERIOR WORK

279. Lathing.—Wooden laths used in plastering should be free from sap, knots, cross-grain, crookedness, and undue smoothness. The sap decays and stains the plaster, the smoothness does not allow sufficient grip for the plaster, and crookedness prevents a uniform distance between the laths. The thicker laths, if there are any, should be used on the ceiling, as more strength is required there than on the side walls. All wooden laths delivered at a building should be protected from rain or snow.

Metal lathing is used extensively on metal studding and also on wooden studding over heat flues, behind tiling, or where greater strength is required than the wooden laths afford. There are many kinds in use, but the better makes do not differ greatly in efficiency. Where Keene's cement is used, the nails should be of galvanized iron or of copper.

280. Lathing Nails.—The nails used for lathing are generally of iron, cut or wrought, or wire. The length of lathing nails depends on the thickness of the laths, nails $\frac{3}{4}$ inch long being used for single laths, nails 1 inch long for lath and half, and nails $1\frac{1}{4}$ inches long for double laths. Composition nails should weigh 10 pounds per 1,000. Copper or zinc nails are expensive, but make a much better job, as they will neither rust nor discolour the plaster.

281. Lime for Interior Plastering.—A rich lime should be used for interior plastering, and should not have more than 6 per cent. of impurities. This lime is unfit for use where much strength is required and for exterior plastering where exposed to the weather.

To ensure perfect slaking for the finishing coat, the lime should stand 2 weeks or more after slaking and until the superfluous water has evaporated. The resultant *lime putty* is reasonably certain to have no small unslaked lumps, thus avoiding blisters in the finished coat. If possible,

sufficient lime putty should be prepared to do all the plastering required in the building. Sometimes, for various reasons, the contractor will not make enough lime putty for the whole building, and if the upper stories are plastered first, the supply may be exhausted long before the lower and more important stories are reached. In this event, some fresh lime putty will have to be mixed, and the contractor, being generally urged to hurry the work along, may be tempted to use this new mixture of putty before it is thoroughly seasoned.

282. Use of Sand in Plaster.—The use of sand in plaster is for the two-fold purpose of regulating and preventing excessive shrinkage and to supply centres of crystallization. The fact that sand is cheaper than lime is sometimes a temptation for the contractor to put in too much sand. The usual proportion for good plaster for the rendering coat is 1 part of lime to 2 or 3 parts of sand. Sea and tidal-river sands should be avoided, as they contain a certain amount of salt, which is sure to discolour the walls and tend to keep them damp. All sand used for plastering in good work should be washed.

283. Artificial Plasters.—Keene's, Parian, granite, and sirapite are the better-known artificial plasters used. They all give good hard surfaces that will take paint well. These plasters are made mixed for the different coats and should be applied according to directions.

284. Plaster Thickness.—The thickness of plaster on wooden lathing should finish about $\frac{7}{8}$ inch thick. Greater thickness than this only imposes extra weight on the laths without corresponding benefit, and thinner plaster is liable to cause cracks, due to too little strength to resist the inevitable shrinkage of the laths.

285. Laying the Plaster.—The first, or rendering, coat in ordinary plaster is composed of lime and sand in the proportion of 1 to 2 or 3 with ox or goat hair mixed in, in the proportion of about 1 pound of hair to every 3 cubic feet of stuff. The second, or floating, coat has a little more sand than the first coat, and a little hair is added also. Fibre is now sometimes substituted for hair, but this should not be allowed. The third, or setting, coat is usually composed of plasterer's putty and plaster of Paris in the proportion of 3 or 4 parts of putty to 1 part of plaster of Paris.

286. Causes of Plaster Cracks.—Cracks in plaster are caused by shrinkage in the framework of the building, too little sand, the use of inferior materials, laying plaster on walls that are too dry, and laying one coat on another before the under coat is properly set.

287. Effects of Plaster Freezing.—If ordinary plaster becomes frozen, its usefulness is destroyed; some patent-plaster walls, if not frozen until 36 hours after being put up, are not harmed.

288. Plastering on Brick or Stone Walls. — Plaster placed directly on brick or stone walls will not obtain a strong bond with the wall unless the stone wall is rough or the joints in the brickwork are scraped out. If these walls have been wet during the construction of the building, they should be well dried out before the plastering is applied, although the surface should be damped enough to prevent excessive absorption of water from the plaster, which will usually cause cracks.

Plaster placed directly on the brickwork of walls that cannot be made hollow may be prevented from being stained by dampness due to rainstorms, etc., by being painted with a waterproof paint on which the plaster can be placed, but which will keep out the moisture. This paint should be put on carefully, so as to cover all points of the wall surface. There is, however, some possibility of this paint hardening with age and finally decomposing enough to allow the passage of water. Nevertheless, in walls of this kind, it is the best method of keeping out the moisture, except, possibly, the oiling of the outer surface or coating with alum and soap solutions, which must be renewed every few years. In wet or exposed districts, plastering direct on walls without a hollow space should never be done when good work is desired.

289. Back Plastering of Ceilings.—To prevent joist lines, which are due to the settlement of dust into the plaster from above, from showing in the ceilings, back plaster between the joists at a few inches above the ceiling, nailing the laths to cleats attached to the side of the joists. This back plastering forms a simple method of deafening the floor, though it is not so efficacious as the proper method of deafening.

290. Plastering Behind Wainscoting.—The wall surfaces behind wainscoting, matchboarding or wall linings, and the wood skirtings should receive a first, or rendering, coat of plaster, as this prevents the run of vermin behind the woodwork, and helps to keep dampness from the back of same should it find its way through the outer wall.

291. Plaster Stains.—The staining of the plaster on wooden laths is usually due to sappy knots, or sometimes to foreign matter that has found its way into the plaster because of an unclean mortar box. A separate mixing box should be used for the setting coat. On brick, terra-cotta, or stone, it is harder to determine the causes, but the use of the waterproof paint or a similar coating will usually prevent such stains. The uncertainty as to the life of the coating is not so important here as where the passage of water is to be prevented, for the plaster will be past the danger of staining from these sources after a few weeks.

292. Temporary Heat.—Temporary heat for drying plaster, etc., is often necessary before the building is completed, and the specification should state plainly whether it is to be furnished by the contractor or by the owner.

EXTERIOR WORK

293. The best exterior plaster for half-timber work, etc., is made of Portland cement and sand. The lighter Portland is perhaps the better, as it sets the more rapidly. Rough cast, or pebble dash, generally consists of two coats of the plaster just mentioned, or lime plaster with hair in the first coat, on which pebbles or other small material are dashed while the second coat is still moist. The pebbles may also be pressed in place one at a time. This work is used for half-timber work and other exterior plaster surfaces.

GLAZIER

294. Window Glass.—Crown, sheet, and plate glass are each used under certain conditions, limited by the character of the work and the details of the manufacture of the glass. Sheet glass, which has almost entirely superseded crown glass, is used for building purposes in four qualities, namely, best, seconds, thirds, and fourths. The last mentioned, being a very common quality, is used only for inferior situations, such as cottages and workshops. Sheet glass is available in much larger sizes than crown glass, and in six thicknesses, from $\frac{1}{14}$ inch to $\frac{1}{5}$ inch; it varies in weight from 15 ounces to 42 ounces per square foot. Every $\frac{1}{16}$ inch in thickness adds 13 ounces to the weight per square foot.

TABLE XIII

SIZES AND WEIGHTS OF SHEET GLASS

Weight Ounces Per Superficial Foot	Thickness Inch	Maximum Length Inches	Maximum Width Inches	Maximum Area Square Feet
15	$\frac{1}{14}$	60	38	15
21	$\frac{1}{10}$	80	50	26
26	$\frac{1}{8}$	80	50	25
32	$\frac{1}{7}$	75	48	20
36	$\frac{1}{6}$	70	44	17
42	$\frac{1}{5}$	60	40	15

The largest sizes available in sheet glass are shown in Table XIII. A sheet may be of the maximum length or the maximum breadth there given, but no combination of length and breadth can be obtained which will exceed the area given in the last column, and any size larger than 36 inches by 50 inches is subject to a special price above the regular market quotations. Sheet glass is sold in crates, the contents of which

vary according to the thickness of the glass. Selected sheet glass is sometimes polished on both sides, and when so treated is called *patent plate*, or *blown plate*, to distinguish it from the ordinary polished plate.

295. Plate Glass.—Plate glass is cast and not blown to the required form; therefore it is always much thicker than blown glass, and until polished lacks the transparency obtained by the other methods. Inferior grades are likely to contain air bubbles and other imperfections, but the superior varieties are completely free from imperfections and do not distort or deform objects as do crown and sheet glass. The three principal varieties of plate glass, rough-cast plate, rough-rolled plate, and polished plate, are distinguished by different surfaces, formed in the process of casting or by subsequent grinding and polishing. Polished plate glass is made with more care than rough-cast plate and from superior material. It is sold in thicknesses of $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$, and 1 inch, the area of the sheets varying from 25 to 280 feet, the latter being exceptional.

The edges of bevelled plate glass are ground, smoothed, and polished to form a bevel, or a border which is not in the same plane as the general surface of the glass. This greatly enhances the appearance of a pane by giving a brilliant finish to the edges, and is performed on one or both sides of the glass by means of a series of revolving discs of cast iron, stone, and willow wood.

296. Obscured Glass.—For situations in which glass is required to intercept the vision while still transmitting light, a great number of obscured glasses are to be obtained, in addition to rough-cast plate and rough-rolled plate. These are made in sheet, or plate, glass, in an immense variety of surfaces and patterns. The best-known varieties are ground, fluted, muffled, crystalline, and figured rolled glass. Obscured glass is used for windows of lavatories, etc.

297. Wired Glass.—Wired glass is made $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{7}{16}$ inch thick, and up to 40 inches wide and 120 inches long. It is practically burglar-proof and missile-proof, and when set in approved metallic frames forms a most efficient fire-retardant window. As a fire-stop, it possesses the advantage that it does not hide the incipient blaze, like steel-plate or metal-lined shutters. Windows glazed with wired glass require no shutters for protection, but, when necessity arises, an opening may be made in the glass by a blow from a fire-axe.

298. Prismatic Glass.—Prismatic glass is made in individual prism lights, as pressed prism plates, which consist of pressed lenses 4 or 5 inches square, glazed together with a cast-iron or copper bar, and as rolled or sheet prisms, which are first rolled in large sheets and then cut to size. Special prisms are manufactured for throwing the light by means of refraction backwards from the lighting area, into basements and vaults.

These are manufactured by a number of companies, who issue complete illustrated catalogues of their goods, which should be consulted before the specification is written.

299. Puttying Windows. — For iron frames, use putty; bed thoroughly, and back putty. Putty for frames and sashes should be made of pure raw linseed oil and whitening. Salad oil or tallow is sometimes added where the panes are large and liable to movements due to expansion and contraction. All glass should be bedded in a layer of putty, and should be secured by triangular points of sheet zinc, called *sprigs*, which are covered by the final puttying.

300. Setting Large Window Panes.—Shop-front panes are set in patent frames or in cast-iron angles with wooden stops; it is very necessary to keep the glass from coming in contact with the iron. The joints should be made tight with putty. The stops in this work should be fastened with screws so that they may be easily removed for repairs.

301. Saddle Bars. — Leaded glass lights are stiffened and often entirely supported by horizontal saddle bars of square or round section. They are made of iron, steel, zinc, or copper, and are wired and soldered to the leading. Broad lights of more than 30 inches in wooden sashes should have the additional support of saddle bars fixed to the frame and wired and soldered to the sash. Vertical bars are called *stanchions*, and horizontal bars, *saddles*. Saddle bars and stanchions are sometimes let into stone jambs, head, and sill.

302. Art-Glass Skylights. — Skylights of art glass are used with good effect, but should of course be under and protected by an outer or exposed skylight.

303. Wooden Sashes for Leaded Glass.—For residences, the wooden sash in which leaded glass is to be inserted should be sent to the manufacturer for that purpose. This is the safest method, and the specification should state that the contractor is to send the required sash to the manufacturer and pay the carriage both ways, or else the glass manufacturer is to take his own sizes and be entirely responsible for any mistakes made.

PAINTER

MATERIALS

304. Knotting.—To prevent their appearance in the finished work, all knots should be covered with some substance that will arrest their absorbent quality or close the apertures of the fibres, and thus prevent the

effusion of gum or sap. A preparation, or patent knotting, is readily procured, and is much used. Bad knots should be cut $\frac{1}{16}$ inch below the surface and flushed with stopping.

305. Putty. — Putty should be composed of whitening, white lead, and pure linseed oil. The use of oils other than linseed causes the yellow spots over nail heads that are often seen on otherwise good work.

306. Fillers.—Fillers are composed of linseed oil, japan, and some base that is non-absorbent, such as ground glass or corn starch. This compound should be fairly translucent, it should not be diluted, and should be frequently stirred to keep the binder distributed. Fillers are used to fill the open portions of the grain in the wood, so as to obtain an even and impervious surface for the varnish coat. They should be well rubbed into the pores and across the grain.

307. Oils.—Linseed oil is recognized as pre-eminent for use in paints, but as there are a great number of other drying oils and about thirty non-drying oils to be had, it is evident that the purity of the linseed oil used is a matter of great importance and one that the architect should closely watch. Boiled oil is a combination of raw oil and driers boiled, which improves the drying qualities of the oil. Boiled oil dries in about one-half the time that it takes for raw oil. Linseed oil, poppy oil, hemp oil, etc., are drying oils. Non-drying oils are cottonseed, olive, castor, etc., and are not suitable for paints or varnishes, as they do not dry and also contain elements that decompose.

308. Lead.—White lead is a carbonate of lead produced by several methods. The best is obtained by means of the Dutch process, which consists in the taking of gratings of pure lead and exposing them to the fumes of acetic acid. Red lead is an oxide of lead prepared by heating massicot in a furnace. The adulterants used are oxide of iron, brick dust, etc.; oxide of iron is made from iron ore. Zinc white is a hydrated zinc carbonate or oxide, and is suitable for interior work. It has not such good covering qualities as lead, and should have a small amount of white lead mixed with it.

309. Colours. — The different coloured paints are obtained by mixing the various colour pigments with white lead or zinc white and linseed oil, except the metallic paints, which use an inert pigment with oil and a drier, the colour being usually controlled by the pigment.

310. Paint for Brick Walls.—Brick walls will usually take about two coats, with $\frac{1}{2}$ gallon of linseed oil added to each gallon of paint for the first coat.

311. Paint for Roofs.—Tin roofs and ironwork are often painted with red metallic paint (oxide of iron in linseed oil). Metal work may also be painted with lead and oil or aluminium paint, with good results.

312. Distemper.—Distemper or cold-water paints are used for painting wood, plaster, stone, or brickwork, and are made of pigments mixed with water and glue, or some other like substance for a binder. Distemper is much darker when first applied, becoming lighter as it dries. Enough mixture should be provided to do an entire room at one time, as it is very difficult to match a tint in making a new supply of colour. Washable distempers have just enough oil in them to be insoluble in water. A water paint resembling an oil flatted paint is now manufactured. It is made up from a base of zinc white, and is free from lime, whitening, and china clay. The relative cost of distemper, washable distemper, and oil paint is about 1 to 2 to 3.

313. Blackboard Paint.—Paint used for blackboards may be made with silicate of soda (soluble glass) and water in equal parts, with just enough lampblack added to colour it.

314. Enamel Paints.—White-enamel paints that dry with a gloss are made. They are placed on a foundation of successive coats of white lead or white lead and zinc white. In best work, the coat immediately beneath the enamel should be of zinc white.

315. Stains.—Stains are preparations in liquid form that are applied to woods for the purpose of imitating other more expensive woods or for unique colour effects. Where stains are used to alter the colours of open-grained woods, the stain is mixed with the filler, the balance of the finishing being done as described for natural finish. Stains should not contain fatty oils nor acids that will act on the varnish. Water stains are more transparent than oil stains, but raise the grain of the wood.

316. Glue Size.—Glue size may be prevented from decomposition by the addition of a little carbolic acid or essence of peppermint or cloves.

317. Varnishes.—Varnishes are solutions of different gums in oil, turpentine, or grain alcohol. Turpentine is sometimes employed for thinning varnish, but should never be used. The architect should determine by tests that a varnish is pure, then specify it by name or number, and insist on its being delivered at the building in sealed packages.

318. Coats of Paint Required.—New work should have at least three coats of paint following the priming coat; four coats will give the best results, however. Painting over old work, if the work is in fair condition, will require only two coats of paint, unless the old work is dark and the new is to be light, in which case probably three coats will be needed. The first coat, called *priming*, is applied for the special purpose of diminishing the absorbent quality of wood or plaster. This is generally a mixture of white lead and red lead, with a proper proportion of driers. This priming should be mixed with boiled oil for outdoor, and linseed oil for indoor, work, adding in each case a small proportion of turpentine,

in the proportion of 3 parts of oil to 1 of turpentine. The back of finishings, the under side of staircases, seats, etc., should be painted before being put in place, to protect against dampness, dry rot, etc.

319. Applying Paint.—Paint should be put on with strokes parallel with the grain crossing and well brushed out, and the painter should make the finishing strokes the full length of the pieces. Ironmongery may be saved the daubing and spattering by painters if it is fitted and then removed until the painting is done, when it is again replaced. The window glass should also be protected from spattering paint, which is sometimes difficult to remove.

320. Preparation of Woodwork. — Before being painted, woodwork should be seasoned and dry and free from dust, and the quirks and cracks should be thoroughly brushed out. Painting in frosty weather is quite likely to result in blisters, due to small quantities of frost that remain under the paint. All wood should be smooth, and the knots should be thoroughly killed.

321. Causes of Blistering and Cracking.—*Blistering* is due to wet or frosty wood, pitchy spots not properly treated, too much oil in paint used on the surfaces much exposed to the sun's heat, or too little time allowed between coats. *Cracking* of paint is due to too much oil in the under coats and too little in the top coats, and the excessive use of driers.

322. Painting and Puttying.—Putty for skylights should contain a non-drying oil that will keep the putty elastic and prevent cracks. Window sashes should be painted before puttying. If they are not painted, the wood will absorb the oil from the putty and render it brittle. Where very heavy sheets of glass are used, they should be well back-puttied and sprigged.

All exposed water-supply, soil, or vent pipes should be painted with either lead-and-oil or aluminium-bronze paint, or both. Newly plastered walls should not be painted or papered immediately ; they should stand at least 3 months and should then be coated with a good liquid filler, and the blisters or unslaked spots cut out and stopped before painting or papering is done. No glue sizing should be used for painting on. Old painted walls need only be washed thoroughly with soap and water and cleaned of loose scale before painting. Two coats will usually be sufficient. All flatted surfaces should be *stippled* to obtain a good effect.

323. Painting Door Panels. — Panels of doors that are to be painted or stained should, if possible, be treated before being incorporated in the door, so that any shrinkage that may occur will not expose the unstained or unpainted wood, which would be the case if the painting or staining were done after the door is made.

324. Painting Ironwork.—Ironwork should be cleaned of rust, scale, dirt, etc., before painting. This is done by rubbing the ironwork with benzene, brushing with wire brushes, scraping, or tapping with hammers. The durability of the paint applied to ironwork depends very much on the care with which this cleaning is done. The paint used is iron-oxide, bituminous, tar, or oil paint, according to the situation of the work. For interior grilles, etc., wrought and cast iron may be painted in imitation of bronze with very good effect.

Structural cast iron or steel should be thoroughly painted with two coats of an iron-oxide paint before leaving the works, and as soon as it is erected it should be given two additional coats. Before applying the first coat of paint, all scale and rust should be entirely removed, for if any particles remain, they will cause the paint to peel off. This cleaning of the surface of ironwork is of the utmost importance and it is seldom done thoroughly. If the steel delivered at the building shows any signs of scale, etc., under the paint, it should be cleaned of both paint and scale and repainted. Where possible, the structural ironwork in a building should be painted, where it is exposed, every 3 to 5 years.

325. Painting Old Woodwork.—Where old work is to be painted, all loose scales and dirt should first be removed by solvents, scraping, or burning. Old paint may be removed by means of quicklime, naphtha, wood alcohol, caustic soda, or a spirit lamp.

326. Cleaning Paint Work.—To clean white paint work, rub with a paste of whiting and soap powder, and afterwards wash and rub dry with a soft cloth. No whiting should be used when cleaning dark-coloured paint.

VARNISHING

327. Varnishing Temperature. — Varnishing whenever possible should be done in a temperature of about 70° F. that is as free from moisture as possible.

328. Dull and Bright Finish.—A good job of varnishing may be obtained with two or three coats of varnish besides the filler. If a dull surface is desired, the under coats should be rubbed down with sandpaper or curled hair to take off inequalities, and the last coat with pumice stone and oil or water. If a bright gloss is desired, the last coat should not be rubbed, or only very slightly. Care should be taken to clean the pumice, etc., out of quirks, cracks, etc. Dull surfaces for varnish may also be obtained by the use of *flat varnishes*, or those containing wax or other substances that give a surface similar in appearance to a rubbed varnish. Paint may be rubbed to a dull surface in the same manner as varnishes. Where a wax finish is desired on a varnished surface, beeswax dissolved in turpentine to the consistency of oil should be used. This is applied

with a brush, and, after being dried, is followed with a coat of the consistency of clotted milk. This coat should be rubbed with a soft cloth until dry. The best waxing is done with dry cake of wax and rag moistened with turpentine, with the minimum of wax and the maximum of rubbing. All floors that are to be varnished are first filled with shellac or paste filler, and then given two coats of floor varnish. The finishing coat may be left glossy or rubbed to a dull finish with pumice and oil. Varnish is sometimes used instead of filler.

329. Varnishing Close- and Open-Grained Woods. — All close-grained woods that are to be varnished should be filled with a shellac varnish. Open-grained woods that are to be varnished should be filled with a paste filler, coloured according to the wood or stain.

ORNAMENTAL METAL WORK

330. Metal Work.—In architectural work, ornamental metal work, outside of lighting fittings and ironmongery, includes cast- and wrought-iron work and cast bronzes or brass. Cast iron is used in this connection for window frames and mullions, sills, staircase newels, strings, balusters, panels, tracery, grille-work, etc.

331. Patterns for Castings.—The patterns, or models, used for making castings are generally of wood, but are also of plaster of Paris, or even of bronze or iron where a great many castings are to be made. For large work, wooden patterns are used. Patterns for fine work, such as ornamental mouldings, capitals, etc., are modelled first in wax or clay, from which a casting is made in plaster of Paris. This casting is used in making the mould.

332. Wrought-Iron Work.—Wrought iron is used for bank grilles, lift enclosures, lift cages, window guards, gates, fences, lamps, balcony railings, staircase railings, ornamental wall anchors, chimney anchors, finials, ornamental strap hinges, etc. An attractive surface for wrought-iron work, where used for wall anchors, shields, torches, or the like, is obtained by allowing the natural hammer marks to remain. Square-head bolts, screw-head bolts, countersunk-head bolts, button-head bolts, tap bolts, lagscrews, and expansion bolts are used to fasten wrought- and cast-iron work. Iron fences are fastened to stone copings or to stone posts in the ground by means of melted lead, cement, sulphur, or resin. Lead, however, is best for this purpose.

333. Moulding Ironwork.—Mouldings in cast or wrought iron should not have too fine members or deep quirks, but should be rather plainly and coarsely moulded.

334. Bronze Work.—Cast bronze is used for memorial tablets, busts, statues, lamps, sundials, hinges, etc. Exposure to the weather produces a considerable change in the appearance of bronze. This is due to oxidization, and the coating formed is called the *patina*, which protects the metal from further oxidization. Bronze tablets or other bronze work should be fastened to stonework or brickwork with bronze expansion bolts, the heads being covered with rosettes or buttons. Phosphor bronze is a bronze containing a certain amount of phosphorus, which adds greatly to its hardness. It is suitable for foot-scraper blades, bearings, hinges, door-knockers, special bolts, etc.

335. Brass Work.—Wrought brass is applicable to most of the purposes of wrought iron, though of course more expensive. The bright polish taken by brass renders this metal invaluable in some classes of decorative work, such as internal grilles, balustrades, ironmongery, etc. Polished brass as a finish with cast bronze makes an attractive combination. Turned and polished brass or bronze should not have very deep or sharp fillets or quirks, as they are difficult to get at with the buffer and must be polished by hand, thus adding much to the expense.

336. Gunmetal.—Gunmetal is an alloy of copper and tin, and does not suffer on exposure to the weather. Brass, bronze, and gunmetal may be turned in the lathe.

STRUCTURAL IRONWORK

337. Steel Construction.—Where skeleton construction is used, after the general setting out of the building has been determined, a structural engineer should be called in, who sets out the framing plans to suit the conditions of the design, calculating the weights and dimensions of the joists and columns and the sizes of their supporting piers and foundations, according to the loads they will have to carry. In ordinary construction, where a steel joist is only occasionally used to span an extra-wide opening or the structural work is of a simple character, the services of an engineer are hardly needed. The steel manufacturers issue handbooks that contain tables which enable the architect or the engineer to pick out suitable steel joists for given conditions. Cast-iron lintels over 4 feet in length should not be used.

338. Bearing-Plates.—Bearing-plates for joists or girders should set back slightly from the face of the wall, in order that there may be no tendency to crack or chip the corner from the brickwork or stonework. Where *stone corbels* are used for the bearing of steel joists or girders, they should have the front edge chamfered.

339. L and T Trusses.—For spanning wide openings, trusses composed of steel L's and T's may be built. For a given strength, they are much lighter and cheaper than wood.

340. Columns.—Cast-iron columns are suitable for ordinary work, but built-up columns of different rolled-steel shapes are the best. The manufacturers' handbooks give the strength of various sizes and lengths of rectangular and round cast-iron columns, but, as a rule, the built-up columns must be calculated. Columns vary considerably in strength, according to the method of securing the ends. If both ends are fixed, the column will be much stronger than if either both ends are loose or only one end fixed. The importance of firmly bedding column bases is therefore easily seen.

341. Jambs and Saddles.—Cast-iron jambs are used at lift and other doors in warehouses, factories, etc., where there is considerable trucking and liability to knocks.

QUANTITIES AND ESTIMATING

(PART 1)

BILLS OF QUANTITIES

GENERAL PRINCIPLES

METHODS USED

1. Definition.—The object of quantities and estimating is to prepare a complete list of the material and labour required in the erection of any proposed building, and from this list to estimate accurately the cost of same. The prime considerations are a thorough knowledge of building construction and its terms, accuracy, and time; on the two latter all efforts must be concentrated. Though one should endeavour to do a maximum amount of work in a minimum amount of time, this should not be done at the expense of accuracy, for accuracy is the most important factor.

2. Systems in Use.—The rules, data, and system here given are those in use in London, which are generally acknowledged as being the most accurate and complete system, and work prepared under this system will generally be accepted in any part of the British Isles. But the systems used in various parts of the British Isles differ considerably from the one used in London. In the North of England each trade is tendered for and carried out by a separate contractor; this means a very careful splitting up of items into their respective trades. The Manchester

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Society of Architects, as early as 1866, issued a general statement of the methods which they recommended should be used. These methods, which have been revised from time to time, have been largely adopted in that district. But if a person understands the London system, it is comparatively easy to adapt that system to any other which may be general in another neighbourhood.

3. **Approximate and Accurate Methods.**—**Approximate methods** of arriving at the amount of material, labour, and cost for any given work are in use, and, as pricing forms the most essential part of all approximate methods, they will be dealt with under the heading of Approximate Estimates. **Accurate methods** are easily divided into two classes: (*a*) *Bills of quantities*, which is the most satisfactory way of arriving at the cost of a building before erection. If care is taken in the preparation of these bills and the work is not varied very much during execution, it is certainly the most accurate of all methods. (*b*) *Schedules of prices*, which will be dealt with after having gone through bills of quantities, as they will then be better understood.

ORDER OF OPERATIONS

4. **Introduction.**—A **bill of quantities** should contain the entire labour and materials involved in the erection of a building. It is prepared from the drawings and specification of the building by: (*a*) *taking off* on to *dimension paper* a complete list of all labour and materials involved in the building, (*b*) *squaring* the dimensions and checking, (*c*) *abstracting* the dimensions and checking, (*d*) *casting* the collection of like items and, where necessary, *reducing* them, (*e*) writing the *bills* and checking. The last four divisions are termed **working up.** If time permits, the completed bills should be carefully examined and a comparison made of a number of the items related to one another and selected at random. This proceeding avoids such mistakes as taking off 10 flues parged and cored, and 20 chimney pots; or 230 yards wood-block floor, and only 201 yards floated bed for wood-block floor. A number of copies of the bills should then be made, carefully examined, and sent to several builders,

who put their prices against the various items. The builder whose total is the lowest or the most favourable is accepted to carry out the work.

5. Scotch Method. — In the Scotch method, billing and abstracting are never used. A surveyor and his assistant take from a set of plans what are termed *notes*, each trade being taken off by itself. An assistant then calculates the quantities and another checks them. The notes are then examined by the surveyor and, if correct, are given to the typist.

6. Dimension Paper.—In Fig. 1 is shown the ruling of the dimension paper used in taking off. The first column is used

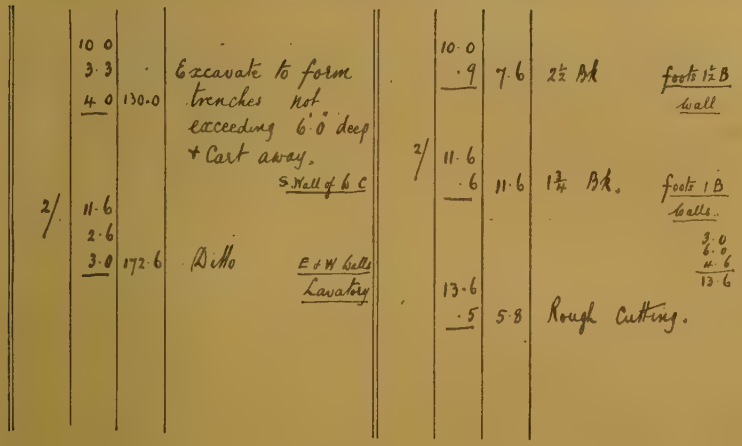

Fig. 1

for **timesing**; that is, stating the number of times an item occurs, if more than once. The second column is for the dimensions; the third, for squaring; and the fourth, for a description of the items, position in the work, and any *wastes*. Dimension paper is ruled with two sets of entries to the page, and is, like all the paper used in quantities and estimating, of foolscap size and ruled on both sides of the sheet. The title of the work should be written at the top left-hand corner of each sheet. The number of each sheet should be given in this corner unless it is decided to number each page or column, when the numbering should be done at the bottom.

7. Wastes.—**Wastes** are collections of lengths, widths, etc., taken from the drawings in sections for the purpose of arriving at a whole and inclusive dimension. For example, the last item in Fig. 1 has three lengths, 3 feet, 6 feet, and 4 feet 6 inches, added together to find the dimension of 13 feet 6 inches.

8. Taking Off.—The process of **taking off** is always considered the most important part of the preparation for a bill of quantities. It is the measuring of the amount of labour and material necessary for the work entailed and writing the same on to dimension paper. For this process, all measurements are obtained from the drawings and all information in regard to the character of the workmanship and the quality of the materials to be used is furnished by the specification. No attempt is made to separate the items into the trades, the items being taken just as required.

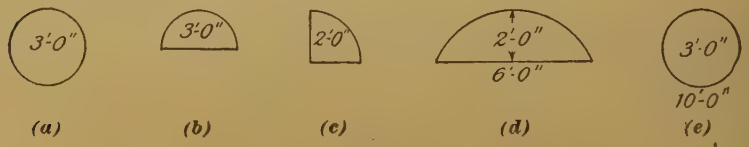

FIG. 2

9. When taking off, the dimensions are placed in the second column of the dimension paper in feet and inches. Single quantities, which represent the *run*, or linear dimension, are placed opposite the items in the fourth column to which they belong. The dimensions of superficial areas and cubes are always taken in the same order, namely, length, breadth, and thickness or depth, and are placed on the dimension paper in the order taken. The area of a circle is shown as in Fig. 2 (*a*); the area of a semicircle, as in (*b*); the area of a quadrant, as in (*c*); the area of a segment, as in (*d*). If any of these are to be *cubed*, the quantity by which the area is to be multiplied is placed under the sign, as in (*e*).

The number of times an item occurs, if more than once, is placed in the first column and separated from the item by a short line. For instance, in Fig. 1, the second item must be multiplied by 2. If it is found necessary to add one more,

a 1 is written below it with a dot between ; thus, $\left|\begin{matrix}2\\ \dot{1}\end{matrix}\right|$ Should the quantity then have to be multiplied by 2 again, a 2 should be placed before the other figures and a line drawn between them ; thus $2\left|\begin{matrix}2\\ \dot{1}\end{matrix}\right|$. This means that the dimension is to be multiplied by 6. A slanting line is equivalent to the multiplication sign and the dot is equivalent to the sign for addition in arithmetic. For example, $2\left|\begin{matrix}3\\ \dot{1}\end{matrix}\right|\left|\begin{matrix}5\\ \dot{2}\\ \dot{1}\end{matrix}\right| = 64$; $9\left|\begin{matrix}5\\ \dot{2}\end{matrix}\right|\left|\begin{matrix}3\\ \dot{4}\end{matrix}\right| = 441$;

$\frac{1}{2}\left|\begin{matrix}6\\ \dot{1}\end{matrix}\right|\left|\begin{matrix}4\\ \dot{1}\end{matrix}\right|\left|\begin{matrix}2\\ \dot{1}\end{matrix}\right| = 30.$

Dimensions are always written on the dimension paper with simply a dot or a dash between feet and inches. For instance, the first dimension in Fig. 1 is written 10·0, which means 10 feet ; the second 3·3, means 3 feet 3 inches, not 3·3 feet as it would in arithmetic. When a dimension is written toward the right-hand side of the column with a dot before it, like the last dimension in Fig. 1, it means inches, the dimension in this case being 5 inches. In squaring and cubing dimensions, if the result comes out to the fraction of an inch, the nearest inch should be taken.

10. Superficial and Cube Measurements. — In taking off quantities, the unit of all surface measurements is taken as the **superficial foot.** This is equal to the square foot, or the area of a square having sides 1 foot long. The **superficial inch** is one-twelfth of a superficial foot ; that is, it is the area of a rectangle 1 foot long and 1 inch wide. Thus, a dimension written 9′ ·3″ super. is read in full " nine superficial feet and three-twelfths of a superficial foot."

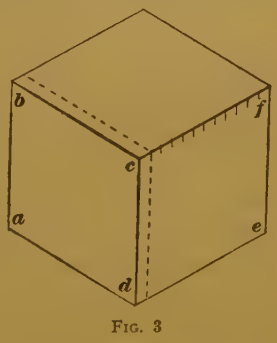

FIG. 3

In a similar manner, the **inch cube** is taken as one-twelfth of a cubic foot. Thus, in Fig. 3, if *a b c d e f* represents 1 cubic foot, a

section *a b c d* 1 inch thick taken across the face *c d e f* will be 1 inch cube. It will be 1 foot long, 1 foot wide, and 1 inch deep. A dimension 8′ ·5″ cube will therefore be read in full "eight cubic feet and five-twelfths of a cubic foot."

Superficial inches and the inch cube are divided into twelfths, which are called **parts.** Thus, in Fig. 3, if the inch cube *a b c d* is divided into twelve equal portions, each portion will be 1 part. Parts are written thus ‴. For example, 5 feet, 7 inches, and 3 parts is written 5′ 7″ 3‴.

From these divisions the following table has been formed:

12 parts = 1 inch
12 inches = 1 foot

11. To multiply feet and inches of cubic and superficial measurements, the following rule may be used:

Rule.—*Consider feet multiplied by feet as feet, feet multiplied by inches as inches, and inches multiplied by inches as parts.*

EXAMPLE.—Multiply: (*a*) 10 feet by 5 inches; (*b*) 9 feet 5 inches by 7 inches.

SOLUTION.—(*a*) By the rule just given,

10 ft. × 5 in. = 50 in., or 4 ft. 2 in. Ans.

(*b*) By the rule, 9 ft. × 7 in. = 63 in., or 5 ft. 3 in. Also, 5 in. × 7 in. = 35 parts, or 2 in. 11 parts. The total product therefore is 5 ft. 5 in. 11 parts, which would be entered on the dimension paper as 5′ ·6″. Ans.

12. Squaring Dimensions.—By squaring dimensions is meant calculating the products of the dimensions and writing the results with ink in the third column of the dimension paper. The various dimensions of superficial areas or cubes are to be multiplied together and the area or cube obtained. This quantity must then be multiplied by the number against it in the timesing column and the product placed in the squaring column. Linear dimensions are to be multiplied by the number of times the item appears, as shown in the timesing column. When squaring the dimensions, also check the wastes. All squaring of dimensions should be checked by another person. They should be ticked in red ink, if correct, or altered in red, if wrong. This procedure is often thought to be very unimportant, but it is one of the utmost importance.

13. Abstracting.—By **abstracting** is meant transferring the amounts and descriptions from the dimension paper to *abstract paper* in the order of the trades. On a large job abstracting is of very great importance, and if properly done helps considerably in writing the bills. It is better to spend time at this stage getting items into correct order and so avoid waste of time when billing, as time is generally very much more valuable then. Sometimes abstracting is done away with for small jobs and the work is billed direct from the dimensions; also, in the North of England, abstracting is avoided by leaving plenty of room between items when taking off. Like items are then added to each other with a note against each one indicating in what part of the building it occurs. However, for buildings of any size, the time spent in abstracting is not by any means wasted.

14. Casting and Reducing.—After all the items have been transferred from the dimension paper to the abstract paper and carefully checked by another person, the abstracts are **cast and reduced**; that is, the columns of figures are totalled and, where necessary, reduced to the denominations in common use, such as yards, rods, etc., ready for billing.

15. Billing.—By **billing** is meant transferring all items from the abstract to *bill paper*; or, if abstracts are not used, direct from the dimension paper. If the abstracting has been properly done, the billing should be in the same order as on the abstract paper. This final stage is also checked by another person. When copies of the bill are made for sending to competing builders, the person preparing the quantities is answerable for the accuracy of the copies, and not the copyist; this, of course, means that all copies must be carefully examined. Two common mistakes are that the number of yards is put into the feet column, and, when superficial items follow cube, the word "super." is not copied, thus making the item read as a cube instead of a superficial. The description of each item written in the bill should be exactly as on the abstract. Should the description of any item not be clear to the biller, the taker off must be consulted before any alteration is made.

TAKING OFF

METHOD OF PROCEDURE

16. Though there are various **orders, or methods, of taking off**, only two are generally used. In one case, each trade is taken off by itself and its dimensions are kept separate. By this method, there are comparatively few dimensions and time is saved in squaring and abstracting; also, the bills can be written as soon as a trade is taken off without waiting for the completion of the whole. The disadvantages of this method are: (*a*) The liability to error, as there is not the continuity of the surrounding work, but a constant jumping about the building; an external door would be dealt with in taking the brickwork for the deduction for the external facing, with the mason for the step, with the joiner for the frame and door, with ironmonger, glazier, and painter, and with the plasterer for deduction internally. (*b*) The separation in the dimensions of the items of a particular piece of work, in the adjustment of a contract involving omissions, or in the case of an omission being directed by client or architect before the bills are completed, causes much work when picking out each item, and is very liable to be incomplete.

17. The more general method is to take off the work in three general divisions: (*a*) The *carcass*, which comprises the preliminaries, excavation, concrete, brickwork, walls, external facings, stonework, coal shoots, areas, light wells, fires, coppers, external pavings, floors, partitions, flats, roofs, and staircases. (*b*) The *finishings*, which comprise openings and recesses where there is no joinery, windows, doors, borrowed lights, staircases, fittings, skirtings, dados, ceiling and wall finishings, ventilation, gas-fittings, bell-hanging, electric bells, electric light, and heating. (*c*) *Sanitary work*, which comprises drains, internal

plumbing, sanitary engineering, and hot-water supply. Although it is admitted that the labour is somewhat greater than in the other method, the work is infinitely clearer and more compact. In the case of variations, which will occur no matter how carefully the drawings and scheme have been thought out beforehand, this method well repays the time spent in the taking off. This second method is the one used here.

RULES FOR TAKING OFF

18. Taking the Measurements.—In taking off quantities, the only scales that should be used are those that have only the divisions used when making the drawings. Thus, if a drawing is made to a scale of $\frac{1}{8}$ inch to the foot, a scale with nothing but these divisions on both edges should be used. Generally speaking, all work should be measured **net**; that is, as set and fixed in the work without any allowance being made for waste of material before or during fixing.

It is a good plan always to start from the same point on the plan and go round the building in the same rotation. For instance, start at the top left-hand corner and work as round the clock. The dimensions should always be placed in the following order: length, width, and depth or height; but care must be taken with the term *depth*. In excavating, depth expresses the same dimension as height, and is placed last. But the depth of a stone is the same as the width of most other items and is therefore placed second. All work taken off should be carefully checked, though often this is not done.

19. Position of Work.—When taking off, the position of all work should be clearly given. If possible, find the points of the compass for the site of the building. If this is impossible, treat the plan as a map and call the top north. It is much easier to describe walls, doors, etc., as north or east, etc., than in any other way. All bedrooms should be numbered consecutively and referred to by number.

20. Headings.—It is a great advantage to have plenty of headings on the dimensions. Avoid, for instance, having a

heading of Windows without another until Doors ; a great deal of time will be wasted if it is necessary to find one particular window. To save time in finding dimensions afterwards, there should be headings of Sash Windows, Casement Windows, Borrowed Lights, Fanlights, Skylights, Lantern Lights, all before the heading of Doors occurs.

21. Figured Dimensions.—Figured dimensions should always be followed rather than scaling. If the drawings have not been figured, much trouble will be saved if the drawings are carefully figured up in pencil, the lengths and breadths of rooms being filled in, and thickness of walls, etc., marked on. But care must be taken that the total of the minor dimensions agrees with the overall length or width. Should there be a figured dimension which is not the actual dimension needed, but an aid to it, it should be used rather than scaling the drawing. Most general drawings are rarely to a larger scale than $\frac{1}{8}$ inch to the foot ; therefore, scaling must be avoided as much as possible.

22. Timesing.—When timesing is necessary, some coloured ink, such as red or green, should be used. No item should be timesed until the whole series of the dimensions is completed. For instance, if three roof trusses are alike, a pencil note should be made at the first item that the following work is to be 3/ ; then, when the taking off of one truss and all items in connection with it is completely finished, the whole may be timesed. By this method errors are avoided, and if at the end the timesing is forgotten, the pencil note will be seen when abstracting.

23. Marking Drawings.—It is a good plan to mark with a small pencil tick on the drawings the parts of the work that have been taken, such as windows and doors. Also, a list should be made at the commencement of a section, like windows or doors, of every window or door on the job, and, when taken, the column or page of dimensions should be marked against it. An example of this is given in Fig. 4.

24. Averaging.—Very often time may be saved by **averaging,** or obtaining an average size of all items that repeatedly occur,

as windows, doors, etc. ; but care must be taken in doing so, and, as a general rule with superficial items, one of the dimensions should be constant. The method of obtaining the average should be clearly shown on the dimensions. It is safe to average windows only when they are in the same thickness of wall

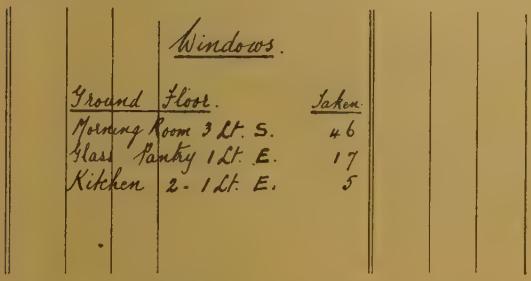

Fig. 4

and all the finishings are alike. If this is not so, many complications will arise which will quickly lead to error. Another drawback to averaging is that, for the purpose of variation, should it be necessary to omit one window the dimensions must be taken again.

25. Repetition of Items.—When there is a repetition of similar items on the dimensions, it saves much writing of description to use the letters *a. b.*, as before, or as last ; but great care must be

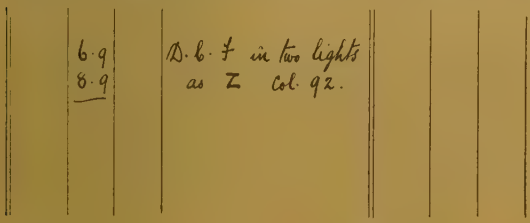

Fig. 5

used, for this is often the cause of error. A better way is to use a letter against the first description and refer back as shown in Fig. 5, where the description reads " Deal cased frame in two lights as Z column 92."

26. Sketches.—In the explanation of a description, sketches are very useful, but they should be used with care. Avoid

making the quantities a picture-book. When a great number of sketches are unavoidable, it is a good plan to insert a note in the preliminaries stating that it must be clearly understood that the sketches in these bills are mere illustrations for purposes of explanation and are not to be taken as a warranty or representation of any measurements or descriptions. A neatly made sketch with the necessary figures will save considerable writing, and at the same time give the builder a much better idea of what is intended.

27. **Alterations.**—When a dimension has been taken, it should not be altered until it has been proved in error. Should it later appear to be wrong, the dimension should be carefully retaken before it is changed on the dimension sheet.

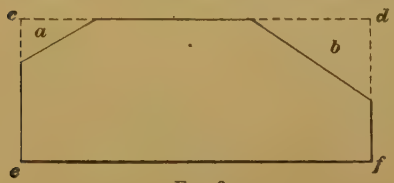

FIG. 6

28. **Wants and Triangles.** **Wants** are portions of work measured in excess; for instance, *a* and *b*, Fig. 6, are wants from the rectangle *c d f e*. In measuring, always take the largest dimensions that can be found and then make the necessary deductions for wants rather than take a quantity piecemeal. By this means the dimensions can be more easily followed at some later date than when each small quantity is taken.

In measuring triangles, enter the dimensions in full and place $\frac{1}{2}$/ in the timesing column, rather than enter the base and one-

FIG. 7

half the height. The correct method for entering a gable 30 feet wide at the base and 15 feet high is shown in Fig. 7.

29. Abbreviations.—The following abbreviations are often used on the dimensions and abstracts, but not in the bills:

A.B.	As before	N.W.	Narrow widths
B. or Bk.	Brick	O.S.	One side
B. & J.	Bed and joint	P. & C.	Parge and core
B. & P.	Bed and point	P.C.	Prime cost, or Portland cement
B.P.P.	British polished plate		
B.S.	Both sides, or Bath stone	P.F.	Plain face
		P.F.I. & R.	Part filled in and rammed
C.C.N.	Close copper nailing		
C.I.	Cast iron	P.M.	Purpose made
C. & P.	Cut and pin	P.M.C.	Plaster moulded cornice
D.C.F.	Deal-cased frame		
Ddt.	Deduct	P.S.	Portland stone
D.H.	Double-hung	P. & S.	Planking and strutting
D.P.C.	Damp-proof course		
E.L.	Extra large	P.S.F.	Picked stock facing
E.O.	Extra only	R. & S.	Render and set
E.O.C.	Extra only in cement	R.B.F.	Red-brick facing
F.E.S.	Feather-edged springer	R.C.	Rough cutting
		R.C.B.M.	Rough-cut birds-mouth
Foots.	Footings		
G.F.	Ground floor	R.F. & R.	Return fill in and ram
G.I.	Galvanized iron		
H.B.	Half brick	R.F. & S.	Render, float, and set
H.B.S.	Herringbone strutting	R.M.E.	Returned mitred ends
H.N. & W.	Head-nut and washer	R.W. & P.	Rake, wedge, and point
H.P.	High pressure		
I.M.	Internal mitre	R.W.P.	Rain-water pipe
L.	Angle	S.E.	Stopped ends
L. & P.	Lath and plaster	S.F.	Sunk face
L.P. & S.	Lath plaster and set	S.L.	Short lengths
L.P.F. & S.	Lath plaster float and set	Super. or Sup.	Superficial
Lt.	Light	T.	Tee
L.W.	Limewhite	W.F.	Wrought framed
M.G.	Make good, or making good	W.I.	Wrought iron
		Y.S.	York stone
M.S.	Measured separately	&	and
N.E.	Not exceeding	&c., etc.	et cetera
N.R.M.E.	Notched returned mitred ends		

The abbreviations are here given as capital letters, but either capital or small letters are used on the dimension paper.

DETAILED ORDER OF TAKING OFF

30. Introduction.—When taking off quantities the following list should be referred to. It is, however, only suggestive and does not contain every item that may be found; but it will help by showing what should be looked for. In some cases it may be advisable to vary it slightly; for instance, when a ceiling may be taken at the same time as the floor over it instead of taking all the ceilings at once. If this is done, the ceiling of the top floor must be taken with the roof or flat. Before any work is done, a list should be made of the drawings and specification that have been received, so that, if necessary, it may be possible to tell if a detail was seen at the time the quantities were taken off. All general preliminaries should be billed direct from the specification.

PRELIMINARIES

Cube of building
Provision for contingencies
Special scaffolding
Hoarding
Screens
Temporary roofs and floors
Difficult access
Work to street pavement
Work to adjoining premises

EXCAVATION, CONCRETE, AND BRICKWORK

Work to party walls complete
Keeping excavations clear of water
Excavation over surface
Planking and strutting where necessary
Excavation to form basement
Excavation, concrete, and footings for external walls below basement, also the brickwork up to ground-floor level, damp-course level, plinth level, or some other convenient point
Excavation, concrete, footings, and brickwork of any projections; that is, bays, piers, etc., on last walls up to same level
Excavation, concrete, footings, and brickwork for external walls where there is no basement, up to same level as before
Excavation, concrete, footings, and brickwork of any projections on last walls up to same level
Excavation, concrete, footings, and brickwork for internal walls below basement up to same level
Excavation, concrete, footings, and brickwork of any projections on last walls up to same level
Excavation, concrete, footings, and brickwork for internal walls where there is no basement up to same level as before

Excavation, concrete, footings, and brickwork of any projections on last walls up to same level
Planking and strutting to trenches as it occurs
All cuttings on foregoing walls up to level taken
Horizontal damp-proof course as it occurs
Vertical damp-proof course, including any additional digging
Angle fillets if damp-proof courses are in asphalt
Brickwork of external walls from last level up as far as they continue of one thickness
Brickwork of external walls above last level up to full height
Gables of external walls
Projections on external walls
All cuttings on external walls
Beam filling
Brickwork of internal walls from first level up as far as they continue of one thickness
Brickwork of internal walls above last level up to the full height
Gables of internal walls
Cuttings on internal walls
Projections of chimney breasts, one at a time, commencing with additional excavation, concrete, and finishing with shafts, if angle breasts take cuttings
Brickwork extra only in cement for last stacks and to any other positions specified
Hoop-iron bond
Wall ties for hollow walls
Joists or girders supporting walls
Coating joists or girders with cement wash, oil, or painting
Ends built in or cut and pinned
Stone templates
Felt or lead seatings
Distance pieces, bolts, and drilling
Cover stones
Cement bed or notches over rivet heads
Casings

WALLER

Foundations
Walling
Cuttings
Levelling up courses
Internal angles
Facings
Dressings

EXTERNAL FACINGS AND STONEWORK

Facing to plinth, if in brick, including additional brickwork down on to footings, and splayed or other course at top, numbering angles and ends, also additional damp-proof course and adjustment for excavating
General facings
Cuttings
Brick strings, cornices, quoins, niches, etc., including any additional brickwork required, and any cement weather fillets
Facing to chimney stacks, including any brick oversailing and ornamental courses, as necking and cap, and adding any additional brickwork, also any stone dressings
Brick or stone copings to parapets and gables, etc., also angle stones, springers, kneelers, bonders, finials, etc.
Vertical tile hanging
External rough cast, including brick or tile course at eaves or other finish, arrises, etc.

External cement work generally, except to doors and windows where not attached to and in connection with other features; take all necessary brick or stone cores for strings, cornices, etc., and all cuttings to form splays, etc.

Terra-cotta generally, except to doors and windows as last

General stonework, including ashlaring, plinths, strings, bands, cornices, copings, etc., complete, but ignoring all dressings to doors and windows where not attached to and in connection with other features. Deduct brickwork and facing for same

Lead covering to cornices, etc.

Granite

COAL SHOOTS

Excavation
Concrete
Footings
Brickwork
Damp-proof course
Facing to sides

Opening in main wall and arch or lintel over
Sloping bottom and benching up for same

Stone top and perforation
Coal plate and frame
Painting

AREAS AND LIGHT WELLS

Excavation
Concrete
Footings
Brickwork
Damp-proof course
Facing to sides

Stone curbs
Steps
Pavement and stallboard lights, grilles, or railing

Mortises and running with lead, etc.
Painting

FIRES

Deduct brickwork for openings
Chimney bars
Relieving arches
Fender walls
Filling to fender walls
Trimmer arches
Centring to trimmer arches
Skew-back cutting
Feather-edged springers

Levelling up on top of trimmer arches
Hearths, front and back
Tile hearths
Curbs
Rendering chimney backs
Rendering over ranges
Flues, parge and core
Chimney pots
Stoves and ranges

Setting stoves and ranges
Black stoves
Black ranges and polish bright parts
Chimneypieces
Fixing only of chimneypieces, if provided
Painting chimneypieces
Ventilators in breasts or flues

COPPERS

Coppers and setting, including finishing to front and on top and furnace work and door

Black furnace work and door
Flues, parge and core
Chimney pots
Copper lids

Soot doors and frames and building in
Black soot doors and frames

EXTERNAL PAVINGS

Excavation, if any
Broken-brick or ballast filling
Concrete bed
Paving
Cuttings
Floated bed for paving, if necessary

FLOORS

Solid Basement Floors or Ground Floors Without Basement

Additional excavation, if any
Rubbish filling
Concrete bed
Granolithic, tile, wood-block, or other floor
Cuttings
Floated bed for tile or wood-block floor

Hollow Basement Floors or Ground Floors Without Basement

Additional excavation, if any
Rubbish filling
Concrete bed
Brick oversailing, if any, to receive plates
Sleeper walls
Extra thickness of main walls to receive plates
Damp-proof course to sleeper walls
Sleeper plates
Ground joists
Flooring
Deductions from flooring for breasts, etc.
Borders to hearths, if measured
Cuttings
Air bricks and painting

Upper Floors of Wood

Floor by Floor

Plates
Joists
Trimmers
Herringbone strutting
Sound boarding, fillets, and pugging
Floor boarding
Deductions from floor boarding
Borders to hearths
Cuttings
Tie-rods with couplings, nuts, and washers and painting
Air bricks and painting
Steps between floor levels

Fireproof Upper Floors

Floor by Floor

Excavation to piers, holes for stanchions or columns
Concrete foundation
Brick bases
Base stones
Rag bolts and holes
Mortises and running
Levelling up bases
Stanchions or columns with bases and caps
Patterns, if cast iron
Planing or machining caps and bases
Countersinking rivet heads
Coating with cement wash, oil, or painting
Casings to columns or stanchions

Main joists or girders
Planing or machining bearing surfaces of girders
Countersinking rivet heads
Coating with cement wash, oil, or painting
Ends cut and pinned
Stone templates
Felt or lead seatings
Connections to tops of columns or stanchions
Distance pieces
Cleats, bolts, etc., to connect to side of other joists or girders
Casing with concrete, where below floor level, or painting if left exposed
Joists as fillers between main joists
Coating with cement wash, oil, or painting
Ends cut and pinned
Stone templates and felt or lead seatings, if any
Ends notched and fitted to side of other joists
Cleats and bolts and holes for same
Fish-plates, bolts, and holes for junctions over main girders
Concrete floor
Chases in wall for concrete floor
Flat-boarded centring
Raking, cutting, and waste
Cement, wood-block, granolithic, tile, terrazzo, mosaic, or other finish
Cuttings
Floated bed for wood-block, tile, terrazzo, or mosaic floors
Deductions for openings
Temporary boarding to edges

PARTITIONS

Quarter Partitions

Floor by Floor

Heads and sills
Interties and wall posts
Angle posts
Braces
Quarters
Posts, etc., to openings
Ends cut and pinned
Bridging pieces
Bolts, straps, and painting

Brick-Nogged Partitions

Heads and sills
Wall posts
Quarters
Nogging pieces
Posts, etc., to openings
Ends cut and pinned
Bridging pieces
Brick nogging
Deduct openings

Concrete Partitions

Concrete partition and temporary boarding and shuttering both sides
Chases in walls
Steel or iron rods
Fixing at ends

Patent Partitions

Partitions
Chases in walls or fillets plugged
Steel or iron rods
Fixing at ends

FLATS

Lead and Zinc Flats

Plates
Joists or bearers
Boarding and furrings
Felt
Drips
Rolls
Lead or zinc
Bossed ends and intersections, etc.
Flashings
Rake, wedge, and point to flashings
Eaves fascia and painting
Eaves gutters and painting
Stopped ends
Angles
Outlets and gratings
Rain-water heads and painting
Gratings in rain-water heads
Rain-water pipes and painting
Bends
Swannecks
Junctions
Plinth bends
Shoes
Connections to drains
Chases or perforations in stone and brick strings, etc.

Concrete Flats

Main joists or girders
Coating with cement wash, oil, or painting
Ends cut and pinned
Stone templates
Felt or lead seatings
Casing with concrete, or painting if left exposed
Joists as fillers between main joists
Coating with cement wash, oil, or painting
Ends cut and pinned
Stone templates and felt or lead seatings, if any
Ends notched and fitted to side of other joists
Cleats and bolts and holes for same
Fish-plates, bolts, and holes for junctions over main girders
Concrete flats
Chases in wall for last
Flat-boarded centring
Floated bed
Asphalt, vulcanite, or other covering
Skirtings and angles and ends
Groove and pointing to top edge
Lead flashings
Rake wedge and point
Turning asphalt into eaves gutter
Lead apron as drip into eaves gutter
Channels or gutters in concrete flat including the floated bed
Asphalt or other lining to channels or gutters
Outlets
Cesspools in concrete flat, including floated bed to same
Asphalt or other lining
Gratings
Socket pipes
Perforations in walls, etc., for socket pipes
Eaves fascia and painting
Eaves gutters and painting
Stopped ends
Angles
Outlets and gratings
Rain-water heads and painting
Gratings in rain-water heads
Rain-water pipes and painting

Bends
Swannecks
Junctions
Plinth bends
Shoes
Connections to drains
Chases or perforations in stone and brick strings, etc.

ROOFS

Trusses

Wood

Tie-beams
Principal rafters
Kingposts or queenposts
Struts
Collars
Ribs
Planing, painting, staining, and varnishing
Straps and bolts, and painting
Iron heads and shoes with patterns, bolts, and painting
Templates
Felt or lead seatings
Ends cut and pinned
Purlin cleats

Steel or Iron

Detail for weight of truss, including cleats for purlins and jaw for ridge, if riveted on
Planing or machining shoes
Countersinking rivet heads
Painting
Shoes cut and pinned
Templates
Felt or lead seatings
Rag bolts and holes
Mortises and running

Purlins

Timber
Planing, painting, staining, and varnishing
Scarfing and bolts and painting
Chamfered or moulded edges
Coach screws or bolts for fixing

Ridges

Timber and scarfs
Rough chamfer
Planing, painting, staining, and varnishing
Chamfered or moulded edges
Coach screws or bolts for fixing
Corbels
Tile or slate ridges
Ends fitted, etc.
Ridge roll
Intersections
Lead
Bossed ends and intersections
Soakers to abutting ridges

Hips

Timber
Rough chamfer
Planing, painting, staining, and varnishing
Tile or slate hips
Cut and mitred hips and soakers
Roll
Ends and intersections
Lead
Bossed ends and intersections

Valleys

Timber and edges
Valley tiles
Valley boarding
Tilting fillets
Lead

Roof Timbers

Plates
Dragon pieces, etc.
Rafters
Cut ends to rafters
Sprockets
Planing, painting, staining, or varnishing
Collars
Ceiling joists and plates

Roof Coverings

Boarding
Felt
Battens
Vertical or ventilating battens
Cuttings to boarding battens and felt
Splayed edges on boarding
Slating or tiling
Cutting and waste on slating or tiling
Verges
Eaves tilting fillets
Eaves course to slating or tiling
Barge boards and mouldings
Mitres and ends
Painting, etc.
Half-timber work
Brackets
Painting, etc.

Flashings, Etc., to Rakes

Soakers
Stepped flashings
Rake, wedge, and point
Tilting fillet to secret gutters
Lead to secret gutters
Stepped flashings
Rake, wedge, and point

Chimney Stacks Through Roofs

Deduct rafters
Trimmers
Deduct tiling or slating, battens, felt, and boarding
Allowances for cutting and waste on all the last items
Tilting fillet to eaves
Gutter boards and bearers
Gusset ends
Roll
Lead to gutter and cover flashing
Rake, wedge, and point to cover flashing
Soakers to sides or secret gutters and tilting fillet
Stepped flashings
Rake wedge and point
Lead apron
Rake wedge and point

Lead Gutters

Gutter boards and bearers
Felt
Drips
Rolls
Gusset ends
Cesspools
Lead to gutters and to cesspools
Cover flashings
Rake, wedge, and point
Snow boards or gratings
Extra labour and solder to cesspools
Gratings
Socket pipes
Perforations in walls, etc., for socket pipes

Eaves, Including Gutters and Rain Pipes

Eaves fascia, painting, and angles
Soffit to eaves
Angles
Mouldings and angles
Eaves gutter and painting
Stopped ends and angles
Outlets and gratings
Rain-water heads and painting
Gratings in rain-water heads
Rain-water pipes and painting
Bends
Swannecks
Junctions
Plinth bends
Shoes
Connections to drains
Chases or perforations in stone and brick strings, etc.

Trap-Doors

Trimming in ceiling joists
Deductions of plastering
Quirks
Linings and painting
Deduct rafters
Trimmers
Deduct tiling or slating battens, felt, and boarding
Allowances for cutting and waste on all the last items
Curbs and painting
Lead coverings
Copper nailing
Tilting fillet to eaves
Gutter boards and bearers
Gusset ends
Lead to gutters
Trap-doors and painting
Lead covering
Copper nailing
Bossed angles
Ironmongery
Ladders and painting

Dormers

Deduct rafters
Trimmers
Plates
Deduct tiling or slating, battens, felt, and boarding
Allowances for cutting and waste on all the last items
Valley tiles
Valley boarding
Tilting fillets
Lead
Ridge
Rough chamfer
Tile or slate ridges
Ends fitted, etc.
Lead soakers
Ridge roll and lead covering
Bossed ends, etc.
Soakers to abutting ridges
Wall and other plates
Rafters
Cut ends
Sprockets
Boarding, felt, battens, tiling, or slating
Cuttings to boarding, battens, and felt
Splayed edges on boarding
Cutting and waste on slating or tiling
Verges
Eaves tilting fillets
Eaves course to slating or tiling
Barge boards and mouldings and painting, etc.
Mitres and ends
Half-timber work
Brackets

Painting, etc.
Studding and boarding to cheeks and felt
Cuttings to boarding and felt
Vertical tiling or slating
Allowances for cutting and waste on tiling or slating
Lead to cheeks
Welts
Copper nailing
Soldered dots
Soakers to sides or secret gutters and tilting fillets
Flashings
Stepped flashings
Rake, wedge, and point
Ceiling joists
Bearers to top
Boarding and furrings and felt
Rolls
Lead covering to top
Bossed ends to rolls
Labour at edges
Copper nailing
Cornice externally
Mitres and ends
Painting
Eaves fascia, painting, and angles
Eaves soffit
Angles
Mouldings and angles
Eaves gutter and painting
Stopped ends and angles
Outlets and gratings
Studding under sill
Lead apron to sill
Metal tongue
Sill and ends
Mouldings
Frame
Mullions
Casements
Labour to bottom edge
Deal cased frames
Moulded horns
Ironmongery
Glass
Linings
Architraves and grounds
Window boards and ends
Moulding under window boards and ends
Painting
Deduction of plastering to general ceiling of room
Plastering to ceiling and to dormer cheeks and under sills
Angles in plastering

Skylights and Lantern Lights

Complete in all trades the items would generally be as required to trap-doors and dormers

Sundries to Roofs

Cat or roof ladders
Ways in roof
Ventilators
Painting
Flèches in all trades

STONE OR CONCRETE STAIRCASES

Steps
Ends cut and pinned
Landings
Risers
Edges cut and pinned
Edges rubbed, etc.
Patent treads
Balusters and newels
Painting
Mortises and running
Ends connected to hand or core rail
Core and hand rails
Ends, ramps, wreaths, scrolls, etc.
Painting
Hand-rail brackets and painting
Ends built in or cut and pinned

FENCES AND GATES

Fences
Gates
Ironmongery
Gate stops and catches

OPENINGS AND RECESSES WHERE NO JOINERY

Deduct brickwork
Arches and cutting
Centring
Flooring and bearers
Deduct skirting both sides
Skirting in openings and recesses
Mitres
Deduct facing or plastering on walls both sides
Add facing or plastering in openings or recesses, including finish to arch
Angles and mitres and stops
Rough chamfer for angles

WINDOWS

Deduct brickwork external reveals
Deduct facing, rough cast, or external cement work
External arches
Key blocks
Centring
Notches for keystones
Cuttings
Stone heads or arches and deduct brickwork and facing
Facing, rough cast, or external cement work to reveals
Stone dressings and deduct brickwork
Cutting on facing up to stone dressings
Stone sills
Ends
Make good facing to ends
Aprons under sills
Fixing bricks or fillets
Frames bed and point
Deduct brickwork internal reveals
Deduct plastering or other internal wall finishings
Fir lintels
Relieving arches
Concrete lintels
Internal fair arches and cutting
Centring
Metal tongue and grooves
Wooden sills
Frames
Mullions
Transoms
Sashes
Labour to bottom edge, stiles, meeting stiles, etc.
Sash beads
Weather fillets
Water bars
Metal casements
Fixing and painting casements
Cased frames and sashes
Moulded horns
Ironmongery
Glass
Glazing beads
Saddle bars and painting
Mortises
Window boards and ends
Mouldings under window boards and ends
Linings
Architraves and grounds
Painting
Plaster or cement reveals
Angles

Rough chamfer for angles
Mouldings to stop plaster or externally
Panelling to window backs and painting
Rendering or canvas behind window backs
Grounds
Capping
Shutters, boxings, ironmongery, and painting

DOORS

External Doors

Deduct brickwork external reveals
Deduct facing
External arches
Key blocks
Centring
Cuttings
Stone heads or arches and deduct brickwork and facing
Stone or wooden hoods
Lead covering
Brackets
Facing to reveals
Stone dressings and deduct brickwork
Steps
Ends
Ends cut and pinned
Concrete beds under steps
Fixing bricks
Dog-irons
Frames bed and point
Deduct brickwork internal reveals
Deduct skirting
Skirting in reveals
Mitres
Deduct plastering or other internal wall finishings
Fir lintels
Relieving arches
Concrete lintels
Internal fair arches and cuttings
Centring
Frame
Iron dowels and mortises
Transoms
Doors
Labours on doors
Ironmongery
Glass
Fanlight
Ironmongery
Glass
Saddle bars and painting
Mortises
Linings
Architraves and grounds
Plinth blocks
Painting
Plaster or cement reveals
Angles
Rough chamfer for angles
Mouldings to stop plaster or externally

Internal Doors

Deduct brickwork, concrete, or patent partition
Item for edges of openings in concrete or patent partitions
Deduct skirting, both sides
Skirting in reveals
Mitres and housings
Deduct plastering or other wall finishings, both sides
Flooring and bearers, thresholds, or steps
Wooden lintels
Relieving arches
Concrete lintels

Fair arches and cuttings
Centring
Fixing bricks
Frames bed and point, if any
Frame
Iron dowels
Transoms
Doors
Labours on doors
Ironmongery
Glass
Fanlight
Ironmongery
Glass
Linings
Architraves and grounds
Plinth blocks
Painting
Plaster or cement reveals
Angles
Rough chamfer for angles
Mouldings to stop plaster

BORROWED LIGHTS

Deduct brickwork, concrete, or patent partition
Item for edges of openings in concrete or patent partitions
Deduct plastering or other wall finishings, both sides
Fir lintels
Relieving arches
Concrete lintels
Fixing bricks
Frame
Sill
Sash
Glass
Linings
Architraves and grounds
Painting
Plaster or cement reveals
Angles
Rough chamfer for angles
Mouldings to stop plaster

STAIRCASES

Treads and risers
Winders and risers
Nosing to floor forming top step
Housings
Ends of steps where cut strings, returned moulded and mitred, or returned and rounded
Cut brackets
Curtail ends and veneered fronts to risers
Notches, etc., to newels
Wall string
Ramps, wreaths, mitres, and ends
Outer string
Ramps, wreaths, and ends
Landing and bearers
Nosing to landing
Nosing to well-hole
Apron linings
Newels
Ends stubbed to floor
Turning to pendants
Sinkings to form panels
Newel caps
Balusters
Core and hand rails
Ends, ramps, wreaths, scrolls, etc.
Hand-rail brackets
Ends cut and pinned
Iron stays
Painting
Plastering to soffits of steps
Plastering to soffits of landings
Plastering to flewing soffits of winders
Quirks
Spandrel and other framings under stairs
Doors in framing
Ironmongery
Painting

FITTINGS

Cupboards, with ironmongery and painting
Shelves and bearers
Slate shelves
Dressers
Painting
Plate racks

SKIRTINGS AND DADOS

Skirtings and painting
Angles
Deductions for fires
Fitted ends
Rough render behind skirtings and adjustment of ordinary plastering
Cement skirtings and painting
Mitres
Stopped ends
Wood dados
Grounds
Angles to dados
Cappings
Painting
Capping mould
Picture rails
Dado rails
Mitres
Painting

CEILING AND WALL FINISHINGS

Ceilings and whitening
Cornices
Mitres, stopped ends, and returned mitred stopped ends
Bracketing
Angle blocks
Enrichments to cornices
Mitres and ends
Deductions for cornices
Centre ornaments
Fair face, point, and limewhite
Plastering to walls and partitions and distempering or papering
Sizing and varnishing on paper
Angles
Wall tiling and floated cement screed for same
Cuttings on wall tiling
Angles to wall tiling
Glazed-brick facings
Angles to glazed-brick facings

VENTILATION

Gratings
Ducts
All trades complete

GAS-FITTING

Opening up ground, footway, etc., and make good
Connection with main and pay fees
Pipe from main to meter
Tarred box in ground
Stop-cock pit and cover
Meter
Shelf and enclosure to meter
Ironmongery
Painting
Short lengths of pipe and connections at inlet and outlet of meters
Siphons

Stop-cocks
Service pipes to fittings
Item for holes through internal walls, floors, partitions, etc., and make good
Screwing down floor boards
Fittings
Fixing fittings and blocks
Attendance
Testing

BELLS, HEATING, AND LIGHTING

Bell Hanging

Bells, wiring, and cranks
Pulls
Bell boards
Holes through internal walls, floors, partitions, etc., and make good
Attendance
Testing

Electric Bells

Bells
Batteries and shelves for same
Indicators
Wiring
Pushes
Holes through internal walls, floors, partitions, etc., and make good
Attendance
Testing

Electric Light

Usually a provision
Item for profit
Item for attendance, cutting away, and making good

Heating

Usually a provision, and with items for profit, etc., as for electric light

Speaking Tubes

Number average lengths of composition pipe, including bends
Lengths of flexible tubing and unions
Whistles and indicators
Holes through internal walls, floors, partitions, etc., and make good
Attendance

DRAINS

Manholes, Cesspools, and Rain-Water Tanks

Excavation
Concrete
Brickwork
Rendering or other finish inside
Oversailings for covers
Stone curbs or covers
Iron covers and frames
Foot irons
Channels and bends in bottom
Benching up bottom of manholes
Making good to inlet and outlet pipes

Gullies, Pipes, Etc.

Gullies, grease traps, rain-water shoes, and intercepting traps with gratings, concrete beds, etc., complete
Raising pieces to these
Drain pipes, concrete bed, and digging, from fittings to manholes and between manhole and manhole
Bends

Junctions
Diminishing pieces
Soakaways
Holes through walls, etc.
Drain pipes, concrete bed, and digging, from the last manhole to the sewer
The same, including opening up ground, footway, and roadway, etc., or tunnelling for last, and make good
Connections with sewers and pay fees
Fresh-air inlets
Upcast pipes and work in connection
Testing

PLUMBING

Water Supply

Well with cover and painting
Pump
Suction pipe with connection to pump and rose end
Iron cisterns
Wooden cisterns
Lead lining
Soldered angles
Copper nailing
Bearers to cisterns
Painting
Templates
Ends cut and pinned
Overflows from cisterns
Unions, fly-nuts, and washers and holes in cisterns
Holes through external walls, etc.
Flaps and frames
Standing waste
Brass washer and waste and fly-nut, and union and hole in cistern
Pipe from same
Lead safe under cisterns with deal curb and bottom
Bossed or soldered angles
Copper nailing
Waste from safe with flap and frame
Enclosures to cisterns and packing with sawdust, etc., and painting
Cistern covers and painting and ironmongery
Joiner attend plumber to cisterns
Connections with main and pay fees
Opening up ground, footway, etc., and make good
Rising main
Tarred box in ground
Stop-cocks
Pit and cover
Water meter, if required
Joints to inlet and outlet of meter
Shelf and brackets and painting
Pit and cover
Ball valve and connection to cistern and joint to rising main
Chases in wall
Pipe casing and painting

Feed-Cisterns

Feed-cisterns with ball valve, and unions at inlet and outlet and bearers
Enclosures and painting
Overflow pipe
Joint to union
Holes through external walls, etc.
Flap and frame
Service pipe from feed-cistern to boiler of range
Joint to union
Connection to boiler, including drilling
Joiner attend plumber to feed-cisterns

Sinks

Stone or glazed stoneware sinks
Sinks of wood
Lead lining
Soldered angles
Copper nailing
Bearers and painting
Brick piers
Brass gratings
Brass grate and plug and rim
Lead cones
Lead traps with cleaning screws
Waste pipe
Bends
Holes through external walls, etc.
Joiner attend plumber to sinks
Draining boards
Enclosure of spaces beneath sinks
Painting to enclosures
Tiling or cement round sinks

Lavatories

Basins, complete with valves and brackets
Slate or marble top
Rounded or moulded edges
Perforations for basins and taps
Skirtings and angles
Basins and washer plug and chain
Valves
Lead traps with cleaning screws and joint to fitting and waste pipe
Waste pipe
Bends
Holes through external walls, etc.
Joints or connections to vertical waste
Vertical waste
Connections to drain
Overflow pipe and joints to basin and waste
Puff or ventilating pipes and joints
Joiner attend plumber to lavatories

Baths

Baths and valves
Lead safe under baths with deal curb and bottom
Bossed or soldered angles
Copper nailing
Waste from safe and flap and frame
Top with perforation, nosing, corners, and deal cradle
Enclosure to front and ends
Door in enclosure
Fastenings
Skirting to top with ends and mitres
French polishing and painting
Lead traps with cleaning screws
Waste pipe
Bends
Holes through external walls, etc.
Connections to vertical waste
Vertical waste
Connections to drain
Overflow pipe and joints to basin and waste
Puff or ventilating pipes and joints
Joiner attend plumber to baths

Water-Closets

Apparatus and trap
Branch soil pipe
Bends
Joint to trap
Thimble, if required
Joint to vertical soil pipe
Junction and thimble, if required
Hole through external walls, etc.
Vertical soil and ventilating pipe
Bends
Connection to drain
Holes in roof for pipe, including lead sleeve and slate
Grating, cowl, or hood to top

Iron stays, with lead slates, etc.
Lead antisiphonage pipe
Branch pieces to traps
Bends
Joints to traps and pipe
Junctions and thimbles, if required
Lead safe under water-closets, with deal curb and bottom
Bossed or soldered angles
Copper nailing
Waste from safe with flap and frame
Seats and brackets
Water-waste preventers
Overflow pipes and joints
Holes through external walls, etc.
Flaps and frames
Flushing pipes
Bends
Joints to union
Connections to arm of water-closet
Seats, risers, and bearers to valve closets
Flaps and frames
Butts
Edges and nosings
Skirting and mitres and ends
Holes for pans and handles
Joiner attend plumber to water-closet and water-waste preventer

Urinals

Stall or range
Trap and cleaning screw
Joint to drain
Waste pipe and joints
Joint to vertical soil pipe
Junction and thimble, if required
Holes through external walls, etc.
Sparge pipes and joints
Automatic flushing cisterns
Drip taps, if necessary
Flushing pipes
Bends
Joints to cisterns and sparge pipes
Joiner attend plumber to urinals

Draw-Offs

Lead safe with deal curb and bottom or lead-lined sink
Bossed or soldered angles
Copper nailing
Waste from safe and joint to vertical or other waste
Holes through external walls, etc.
Joiner attend plumber to draw-offs

Service Pipes

Unions, fly-nuts, washers, and holes in cistern
Pipes from cisterns to each fitting
Branch joints
Joints to each fitting
Bib-cocks and joints as they occur
Stop-cocks and joints on branch services
Chases in wall
Pipe casings and painting
Covering pipes with hair felt
Holes through internal walls, floors, partitions, etc., and make good
Testing

Hot-Water Supply

Cylinder or tank, with unions
Bearers
Cold service from cistern to cylinder or tank
Unions, fly-nuts, washers, and holes in cold-storage cistern
Stop-cocks and joints
Flow and return pipes

Drilling boiler of range for flow and return pipes
Expansion pipes
Branch services
Bib-cocks and joints as they occur
Connections to lavatory and bath valves, including short lengths of lead pipe and all joints and unions
Safety valves
Chases
Pipe casings and painting
Attendance and holes through internal walls, floors, partitions, etc., and make good
Testing

MODE OF MEASUREMENT AND EXAMPLES

EXCAVATION

31. Usually, excavated material is thrown out, but in confined situations, such as pier holes inside existing buildings, it is carried out in baskets. Later, it is returned, filled in, and rammed; or it is wheeled and deposited on the site, or is carted away. If wheeled and deposited on the site, state within how many *runs* of the building it is to be placed. A run is 20 yards. Excavated material is dealt with as before excavation. Although all material increases in bulk after excavation, no allowance is made for this in the quantities. When an excavation exceeds 6 feet in depth, each 6 feet should be kept separate, as the price for every additional 6 feet must include the cost of stagings. If the foundations of old walls are likely to be met with, add to the description "including grubbing up any old foundations that may be met with." Small pier holes should be kept separate.

32. Excavation Over Surface.—Where the excavation over the surface does not exceed 12 inches, it is measured per yard superficial, and the depth is given. Where it is over 12 inches deep, the excavation is measured per yard cube. It should be stated whether vegetable mould is to be separated or grass turfs deposited. The usual method is to commence the measurement of excavation by removing the surface all over the site one spade, or *spit*, about 6 inches deep. In the following examples the dimensions are squared, but in practice, the squaring is not done until after all the items have been taken off.

EXAMPLE.—Take off the excavation over surface for a building, 39 feet 6 inches by 14 feet 9 inches in the clear, that has the longitudinal

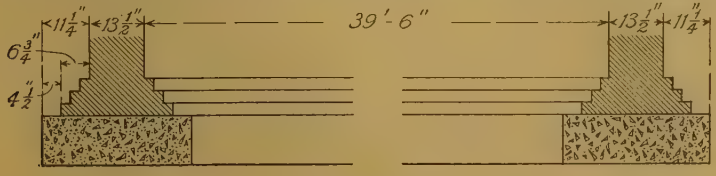

FIG. 8

section shown in Fig. 8, the excavated material not returned to be deposited on the site not more than 3 runs away.

SOLUTION.—To find the length of the excavation, it is necessary to add to the clear length twice the thickness of the walls and twice the amount that the footings and concrete project beyond the walls; or 39 ft. 6 in. + (13½ in. × 2) + (11¼ in. × 2) = 43 ft. 7½ in. This would be written 43 ft. 8 in. The width is found in the same way. 14 ft. 9 in. + (13½ in. × 2) + (11¼ in. × 2) = 18 ft. 10½ in. This would be written 18 ft. 11 in. The area of the excavation, therefore, will be

43 ft. 8 in. × 18 ft. 11 in. = 826 ft. super. Ans.

This item will appear on the dimension paper as shown in Fig. 9.

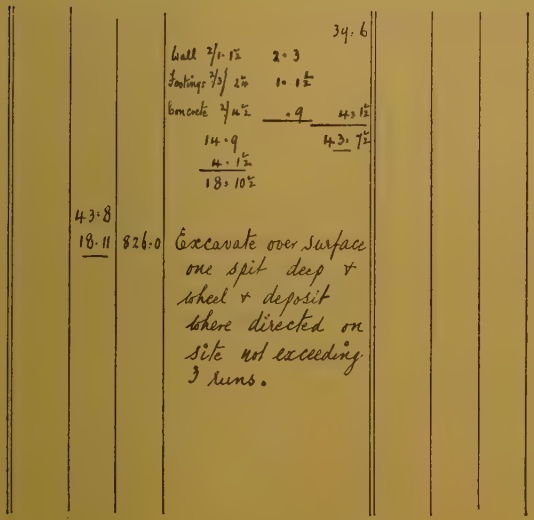

FIG. 9

33. Excavation of Uneven Surfaces.—When measuring the excavations of uneven surfaces, the *average depth* must be taken.

This is found by dividing the length and breadth of the surface into a number of equal parts by means of *section lines* and taking the depth of the excavation at the intersection of these lines. The average depth is the sum of these depths divided by their number. For instance, the plot *a b c d*, shown in Fig. 10, is divided into six equal parts by the section lines *e h*, *f j*, and *g i*. The depths of the excavation at the corners and at the intersections are as marked. The average depth, therefore, is the sum of all these depths divided by 12, or 5 feet.

34. Excavation of an Irregular Site.—An irregular site is best measured by dividing it into triangles, then adding the areas of the triangles. If the surface is also uneven, the depth of the excavation is found by obtaining the average depth of each triangle. The irregular plot shown in Fig. 12 is divided into four right-angled triangles *a*, *b*, *c*, and *d*. The area of each is found and the average depth obtained.

35. Planking and Strutting.—Where the excavations are deep, **planking** and **strutting** must be used to support the earth adjoining the excavation. If this is not done, allowance must be made in the excavation for slopes, but this is rarely done. The planking and strutting to basements or to the sides of an excavation over a site is measured per foot superficial. The planking and strutting to trenches is usually measured per foot run ; one side only is measured and the width and depth are stated. An alternative method for shallow trenches is to add to the description of excavation the phrase " including planking and strutting, if necessary," but it should always be measured when the trenches exceed 4 feet in depth. Where excavations are adjoining the street, the planking and strutting should be separated and described as " Planking and strutting to sides of excavation next street, including any shoring required."

EXAMPLE 1.—Take off the excavation over a site 60 feet by 40 feet, from which the ground must be removed to the depths below the surface shown in Fig. 10 ; allow for planking, strutting, and carting away.

SOLUTION.—As this excavation is more than 12 in. deep, it must be measured per yard cube. To find the average depth, therefore, the

various depths are taken. The depths on *a b* are 5 ft., 6 ft., 7 ft., and 8 ft.; on *e h*, 4 ft., 4 ft. 8 in., 5 ft. 4 in., and 6 ft.; on *d c*, 3 ft., 3 ft. 4 in., 3 ft. 8 in., and 4 ft.; on *a d*, 5 ft., 4 ft., and 3 ft.; on *f j*, 6 ft., 4 ft. 8 in., and 3 ft. 4 in.; on *g i*, 7 ft., 5 ft. 4 in., and 3 ft. 8 in.; and on *b c*, 8 ft., 6 ft., and 4 ft. These added together give 120 ft., which, divided by 24, being the number of depths just taken, gives 5 ft. as the average depth of excavation.

To measure the planking and strutting, each side is taken by itself. The length of the north side *a b* is 60 ft. and the depths 5 ft., 6 ft., 7 ft., and 8 ft.; the average depth, therefore, is $\frac{5+6+7+8}{4}$ = 6 ft. 6 in.

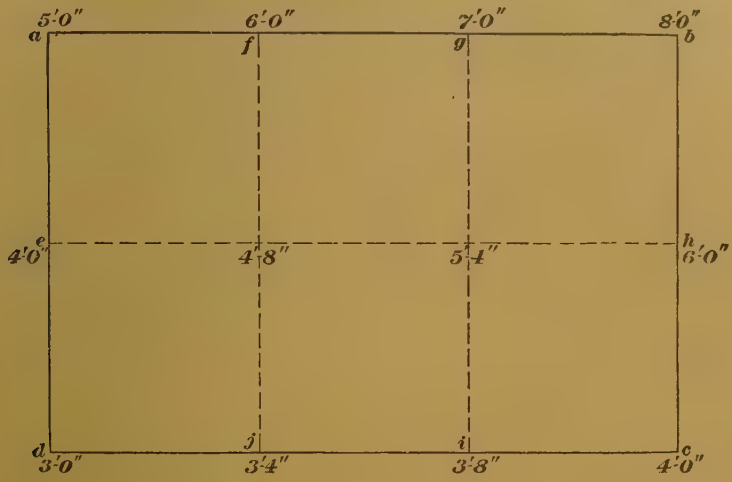

Fig. 10

The area of planking and strutting required for this side, then, is 60 × 6 ft. 6 in. = 390 ft. super. The length of the east side *b c* is 40 ft. and its depths 8 ft., 6 ft., and 4 ft.; its average depth is $\frac{8+6+4}{3}$ = 6 ft. The area of planking and strutting is 40 × 6 = 240 ft. super. The average depth of the south side *d c* is $\frac{3 \text{ ft.} + 3 \text{ ft. } 4 \text{ in.} + 3 \text{ ft. } 8 \text{ in.} + 4 \text{ ft.}}{4}$ = 3 ft. 6 in.; the area of planking and strutting is 60 × 3 ft. 6 in. = 210 ft. super. The average depth of the west side *a d* is $\frac{5+4+3}{3}$ = 4 ft.; the area of planking and strutting, therefore, is 40 × 4 = 160 ft. super.

These depths and the item of excavation are entered on the dimension paper as shown in Fig. 11.

The method of entering this matter on the dimension paper is shown in Fig. 11.

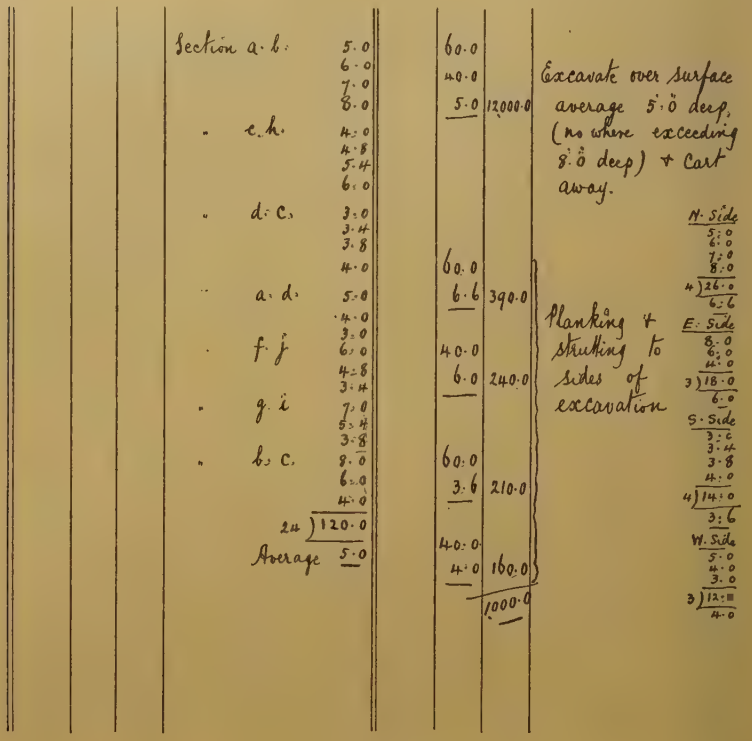

FIG. 11

EXAMPLE 2.—Take off the excavation over the irregular site shown in Fig. 12. The material must be removed to the depths below the surface that are given on the plan. Allow for planking and strutting. The material is to be wheeled and deposited not more than 2 runs away.

SOLUTION.—First divide the site into four right-angled triangles, *a*, *b*, *c*, *d*, Fig. 12. The area of triangle *a* is $\frac{75 \times 25}{2}$ = 937 ft. 6 in. super. Its average depth is $\frac{2 \text{ ft. } 8 \text{ in.} + 3 \text{ ft. } 4 \text{ in.} + 3 \text{ ft. } 5 \text{ in.}}{3}$ = 3 ft. 2 in., very nearly. The excavation, therefore, will be 937 ft. 6 in. × 3 ft. 2 in. = 2,968 ft. 9 in. cube. The area of triangle *b* is $\frac{(25 + 40) \times 35}{2}$ = 1,137 ft. 6 in. super. The average depth is

$\frac{3 \text{ ft. } 4 \text{ in.} + 3 \text{ ft. } 7 \text{ in.} + 4 \text{ ft. } 1 \text{ in.}}{3} = 3 \text{ ft. } 8 \text{ in.}$ The excavation, therefore, will be 1,137 ft. 6 in. × 3 ft. 8 in. = 4,170 ft. 10 in. cube.

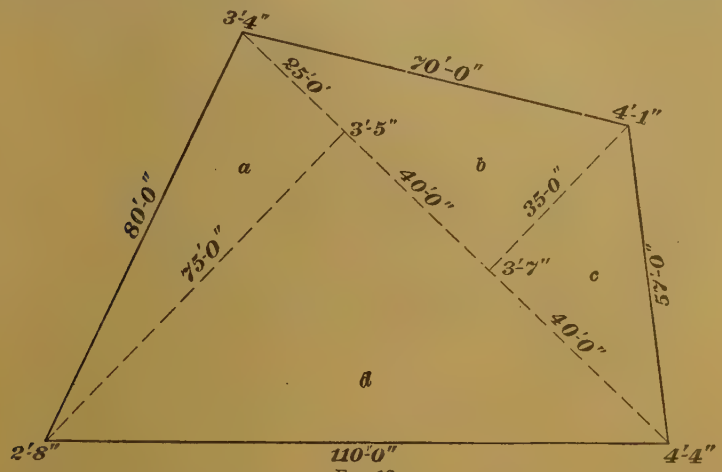

FIG. 12

The area of triangle c is $\frac{35 \times 40}{2} = 700$ ft. super. Its average depth is $\frac{3 \text{ ft. } 7 \text{ in.} + 4 \text{ ft. } 1 \text{ in.} + 4 \text{ ft. } 4 \text{ in.}}{3} = 4$ ft. The excavation, therefore, will be 700 × 4 = 2,800 ft. cube. The area of triangle d is $\frac{(40 + 40) \times 75}{2}$ = 3,000 ft. super. The average depth is $\frac{2 \text{ ft. } 8 \text{ in.} + 3 \text{ ft. } 5 \text{ in.} + 4 \text{ ft. } 4 \text{ in.}}{3}$ = 3 ft. 6 in., nearly. The excavation, therefore, is 3,000 × 3 ft. 6 in. = 10,500 ft. cube. The total excavation is

2,968 ft. 9 in. + 4,170 ft. 10 in. + 2,800 ft. + 10,500 ft.
= 20,439 ft. 7 in. cube

The length of the north side is 70 ft.; its average depth is $\frac{3 \text{ ft. } 4 \text{ in.} + 4 \text{ ft. } 1 \text{ in.}}{2} = 3$ ft. 9 in., practically. The area of planking and strutting required will be 70 ft. × 3 ft. 9 in. = 262 ft. 6 in. super. The length of the east side is 57 ft.; its average depth is $\frac{4 \text{ ft. } 1 \text{ in.} + 4 \text{ ft. } 4 \text{ in.}}{2} = 4$ ft. 3 in., nearly. The area of planking and strutting required will therefore be 57 ft. × 4 ft. 3 in. = 242 ft. 3 in. super. The length of the south side is 110 ft.; its average depth is $\frac{4 \text{ ft. } 4 \text{ in.} + 2 \text{ ft. } 8 \text{ in.}}{2} = 3$ ft. 6 in. The area of planking and strutting

required is therefore 110 ft. × 3 ft. 6 in. = 385 ft. super. The length of the west side is 80 ft.; its average depth is $\frac{2 \text{ ft. } 8 \text{ in.} + 3 \text{ ft. } 4 \text{ in.}}{2}$ = 3 ft. The area of planking and strutting required is therefore 80 × 3 = 240 ft. super. The total area of planking and strutting required is 262 ft. 6 in. + 242 ft. 3 in. + 385 ft. + 240 ft. = 1,129 ft. 9 in. super. The method of entering on the dimension paper is shown in Fig. 13.

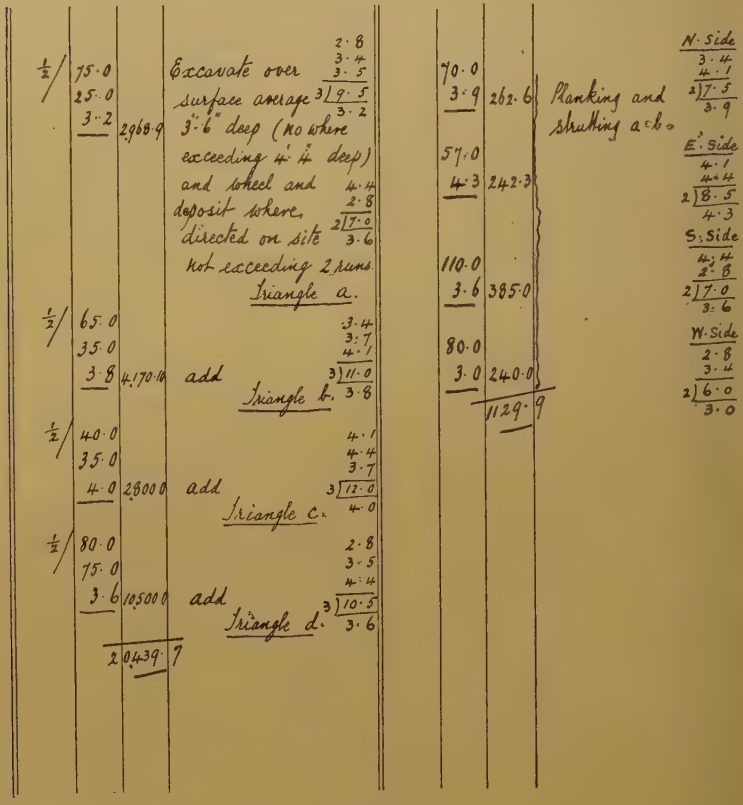

Fig. 13

36. Excavation to Basement.—All excavation to basement is measured per yard cube; the description should state the depth. If a new building with a basement is on the site of an old one which had a basement, the excavation is measured from the pavement level. It is assumed that the material from pulling down the old building will have filled up the voids. In

the case of a building already pulled down, where the voids have not been filled in with the debris, the voids may be deducted from the measurement, but this course is not recommended. In either case it should be clearly stated how the excavation has been measured by inserting the following: "Excavate to form basement, not exceeding 6 feet deep, and cart away. The excavation has been measured from the pavement level and the builder must make what allowance he thinks fit for any voids." Or: "The builder must make what allowance he thinks fit for any void that may exist after the pulling down."

37. Excavation to Trenches.—Trench excavations are measured per yard cube. All trenches which are below the level of the general basement excavation are known as **basement trenches**; all below the level of the general surface only are known as **surface trenches.** Basement and surface trenches should be kept separate; but in every case the depth should be given. Trenches are sometimes described as "part returned, filled in, and rammed, and the remainder carted away," or "deposited," as the case may be. Where the surplus material is to be carted away, and especially in a neighbourhood where a *shoot* is difficult to obtain, the more satisfactory course is to separate the returning from the carting. It is advisable to state either in the beginning of the bill, or with the item of excavation to trenches, that the prices are to include the levelling and preparing the bottoms to receive the concrete.

EXAMPLE.—Take off the excavation for the wall 12 feet long, shown in section in Fig. 14. Part of the material is to be returned, filled in, and rammed; the remainder is to be carted away. Allow for planking and strutting.

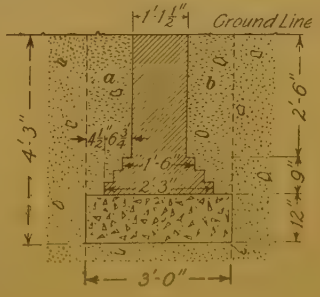

FIG. 14

SOLUTION.—The portion of the trench that is to be filled with concrete is 12 ft. long, 3 ft. wide, and the concrete is 12 in. thick; or 12 ft. × 3 ft. × 12 in. = 36 ft. cube. This is to be excavated and carted away. The remainder of the trench has the same length and width, but its depth is 4 ft. 3 in. − 12 in. = 3 ft. 3 in.; or 12 ft. × 3 ft. × 3 ft. 3 in. = 117 ft. cube. This

should be considered as the amount to be returned, filled in, and rammed; but from it must be deducted the earth that will not be returned because of the wall and footings. The length of the footings is 12 ft.; the width is the average of the top and bottom courses, or $\frac{1 \text{ ft. } 6 \text{ in.} + 2 \text{ ft. } 3 \text{ in.}}{2} = 1 \text{ ft. } 11 \text{ in., nearly;}$ the height is 9 in. Therefore, the footings contain 12 ft. × 1 ft. 11 in. × 9 in. = 17 ft. 3 in. cube. The length of the wall is 12 ft., its width is 1 ft. 2 in., and its height is 3 ft. 3 in. − 9 in. = 2 ft. 6 in.; the wall therefore contains 12 ft. × 1 ft. 2 in. × 2 ft. 6 in. = 35 ft. cube. Therefore, the total amount of material that must be carted away is 36 ft. + 17 ft. 3 in. + 35 ft. = 88 ft. 3 in. cube. The amount that must be returned into the trench is 117 ft. − (17 ft. 3 in. + 35 ft.) = 64 ft. 9 in. cube. As planking and strutting must be provided for both sides of the trench, this will be 12 ft. long and described as to trench 3 ft. wide and 4 ft. 3 in. deep.

The method of entering on dimension paper is shown in Fig. 15.

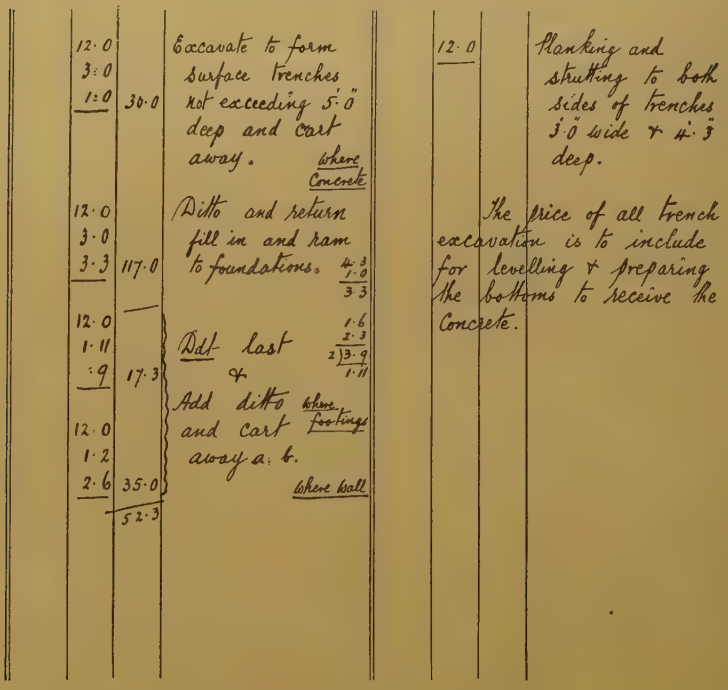

FIG. 15

38. Keeping Excavations Clear of Water.—An item should always be included that all excavations must be kept clear of

water, from whatever cause arising, by pumping, baling, or otherwise. If the ground is water-logged and special difficulties are likely to be met with, a clause should be inserted drawing attention to same. This will ensure the liability of the contractor.

CONCRETE IN FOUNDATIONS

39. Concrete in foundations is measured per yard cube. In all cases its composition should be given. All small pier holes and grillage bases should be kept separate, for they require more labour; the latter in packing round the steel joists and the former because in small quantities. Where the concrete foundations are *stilted*, or stepped, unless otherwise specified or shown, take the lap the same length as the width of the

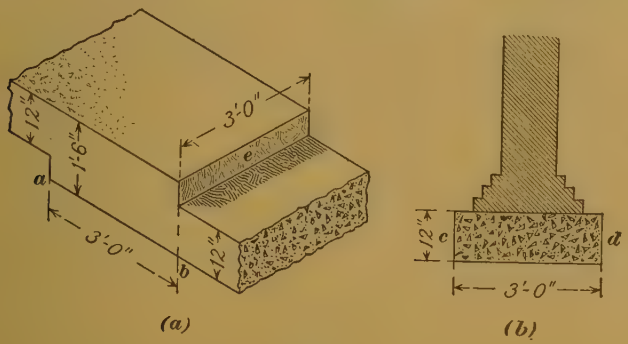

FIG. 16

concrete. For instance, the length *a b*, Fig. 16 (*a*), is the same as the width *c d* in (*b*), so that the additional digging and concrete for this *stilt*, or step, will be 3 feet by 3 feet by 6 inches. In addition, temporary boarding will be required for the edge *e* in (*a*). The item will be written "3 feet run, temporary boarding, and supports to edge of concrete 6 inches high."

BRICKWORK

40. When taking off brickwork, compare the plans floor by floor and see that there is no brickwork shown on the upper floors that has not a support below it. One-brick walls, 9 inches

thick, which are to be faced and pointed on both sides, whether in garden-wall bond or not, must be kept separate and fully described. Half-brick walls, whether as partitions or sleeper walls, are kept separate.

Brickwork over 60 feet above the ground is kept separate in heights of 20 feet and described as 60 feet to 80 feet, etc. All work built circular on plan is separated. Where it is built to a radius of 25 feet and over, it is usually described as "to flat sweep"; where the radius is less than 25 feet, it is called "to quick sweep." It is always advisable, however, to state the radius and to include for the template.

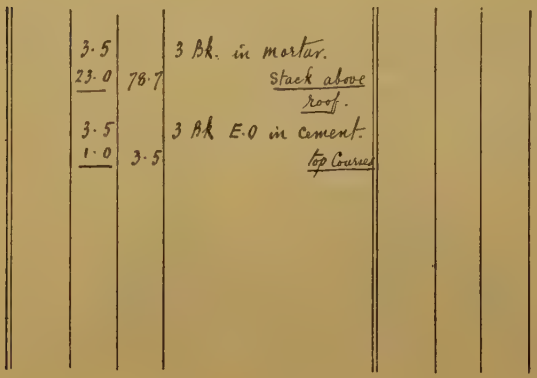

Fig. 17

41. Measurement of Brickwork.—All brickwork is measured per foot superficial, except where the thickness is not brick dimensions, angles, chimney breasts, etc.; in such cases it is measured per foot cube. All general brickwork which is over $\frac{1}{2}$ brick in thickness, $4\frac{1}{2}$ inches, is reduced before billing to either rods or yards. State in all cases whether it is to be laid in mortar or cement. When only a small part of the work is built in cement, it is usual to measure the whole as in mortar and then for the portion in cement to take an item of "Brickwork extra only in cement." For instance, if the top four courses of a chimney stack are specified to be in cement, it will appear on the dimensions as shown in Fig. 17. It is usual to measure brickwork to the top of wall plates, where only 3 inches thick,

to allow for bedding the plate; if not so measured, a running item must be taken of "bedding plate."

42. Brickwork in Backing to Masonry.—Brickwork which is in backing to masonry is usually kept separate, because of the additional cutting and waste entailed; but if there is only a small quantity of stone, the brickwork can be described as "small part in backing to masonry." In the northern and midland counties of England the bricks will rise as much as 13 inches to the four courses, instead of the London average of 12 inches; this will affect both the brickwork and the stonework bonded with it. Where a wall is faced with stonework, it is advisable to measure the wall first as brickwork, then, when taking the stone, deduct from the brickwork what is displaced by the stone.

43. New and Old Work.—Raising on old work, filling in old openings, and brickwork to be built off girders at a good height above and away from other brickwork, should be kept separate and fully described. In addition to keeping the brickwork separate where raising occurs, it is usual to add to the net height a course or two in case it may be found necessary to take down and rebuild; also, the length of the wall raised on is taken as "level and prepare old -inch wall for raising upon." In filling in old openings, take twice the height as "Labour, cut, tooth, and bond new -inch wall to old," and allow in the measurement of the width of opening for brickwork sufficient for the bonding. If the width is measured net, describe the last item as "Labour and material, cut, tooth, and bond, etc." This rule will also apply where new walls are built in continuation of old, or where the ends of new walls abut against the face of old. But where new brickwork is built against old, so as to increase the thickness of a wall, it is best to make the superficial item of brickwork include the bonding. It will then read, "Half brick in cement thicknessing to old wall, including extra labour and material, cutting, toothing, and bonding new to old."

44. Flues and Hollow Walls.—No deductions are made for ordinary flues, the fireplace opening only being deducted. In

the case of a flue to a furnace chimney, the shaft is measured solid and the flue deducted; of course, the brickwork is kept separate and fully described.

Hollow walls are best measured by the foot superficial, describing the thickness of inner and outer skins, width of hollow, description of ties, and the number per yard superficial, and the method to be used to keep the hollow clear of falling rubbish, whether by hay bands or boards. It is the custom in some neighbourhoods to measure hollow walls solid, no deduction being made for the cavity, and then reduce to rods or yards in the usual way, but separating it from the ordinary brickwork; this method is not so accurate as the former and is not advised.

45. Footings and Battering Walls.—Footings are averaged by adding the top and bottom courses together and dividing by 2. The average for the footings to a $1\frac{1}{2}$-brick wall, shown in Fig. 14, is $2\frac{1}{2}$ bricks; that is, the top course is 1 foot 6 inches, which equals 2 bricks; the bottom course is 2 feet 3 inches, which equals 3 bricks. These added together and divided by 2 give an average of $2\frac{1}{2}$ bricks. Walls built with a batter should be kept separate, except when only the face is battered; in any case take a superficial item of "extra to battering face to brickwork."

46. Underpinning.—Excavation, concrete, brickwork, etc., in **underpinning,** are measured in the ordinary way, but always kept separate and described as "in short lengths in underpinning." The description of excavation should make clear that the price must include all planking, strutting, needling, and shoring, and everything necessary for the safety of the work to be underpinned. Sometimes it is advisable to take an item for the full length of the wall to be underpinned, as "Needle and shore up as required old -inch wall while underpinning same, and make good all work disturbed." When the existing footings and foundations of a wall must be removed before underpinning, take items for the full length of the wall. "Allow to grub up and remove the concrete foundations, footings, etc., of existing -inch wall and prepare same for underpinning," and "Wedge and pin up with slates or tiles in cement between new and old -inch wall in short lengths in underpinning."

47. Cuttings. — The *rough cutting* to the rakes of gables and similar positions is measured per foot superficial. **Rough cutting** includes all cutting in brickwork, other than face work, that is not square cutting. When cut fair, it is measured per foot run. A running dimension of *fair cutting* is generally

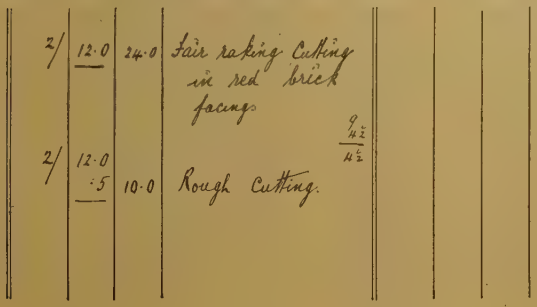

Fig. 18

understood to be for $4\frac{1}{2}$ inches only in thickness. **Fair cutting** includes all cutting in face brickwork that is not square cutting. If a gable 9 inches thick is faced on one side with red bricks, while the other side is left rough or plastered, the length on rake will be 12 feet. The dimensions for cutting to both rakes

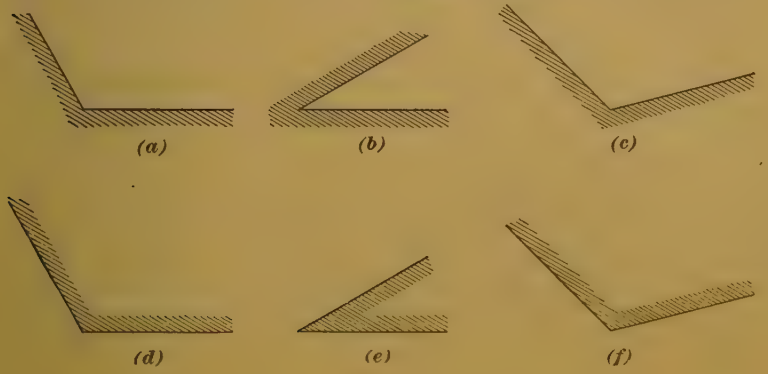

Fig. 19

of the gable will then be as shown in Fig. 18. As the item of rough cutting is of very little value and is often not priced by the builder, it is sometimes considered a waste of time to measure it. In such cases the item of brickwork is described as "including all rough cutting."

48. Cuttings to *birdsmouths* and *squint quoins* are measured per foot run. When on ordinary brickwork, they are described as "rough-cut squint, or birdsmouth," when on facings, as "fair-cut squint, or birdsmouth, in -brick facing." A **birdsmouth** is any interior angle except a right angle, such as at the meeting of two walls. The term is often applied to the interior angle that is cut on the end of a piece of timber for the purpose of obtaining a firm rest on the exterior angle of another piece. Three forms are shown in Fig. 19 (*a*), (*b*), and (*c*). **Squint quoins,** shown in Fig. 19 (*d*), (*e*), and (*f*), are all quoins other than right-angled ones.

49. Damp-Proof Courses.—When horizontal in the walls, damp-proof courses are measured per foot superficial the net width of the wall. When made of slates, it should be described as "horizontal damp-proof course consisting of two courses of stout slates in cement laid to break joints, measured net width of wall." If asphalt sheets are to be used, state the maker and quality and also describe as "measured net width of wall." If mastic asphalt is used, sometimes it is specified to be cut back $\frac{1}{2}$ inch from external face and pointed in cement. The correct way is to take an item per foot run for this, but sometimes it is included in the superficial item of damp-proof course.

Vertical damp-proof courses are measured per yard superficial. The description should include raking out joints of brickwork as may be necessary to form a key ; it should also include any extra digging required for working room beyond the trench excavation. Measure per foot run any angle fillets at the junction with the horizontal course or at internal angles, also arrises at external angles. The latter, however, are more often included in the superficial item. Where the vertical damp-proof course is asphalt and is to be continued up above the ground and finished as plinth, the total length must be taken as "extra labour and material turning in top edge into groove in brickwork, including cutting groove and pointing with cement."

50. External Walls.—When taking off external walls, carefully classify them according to their thicknesses; thus, 1, $1\frac{1}{2}$, and 2 bricks, etc., and for each give its position in the work, as

shown in Fig. 20. Ignore in this collection all extra thicknesses for plinths, sleeper walls, etc., for these are taken later. Also ignore all bays which occur on one floor only ; measure the wall through as if there were not a bay, and adjust for this later. The object of this arrangement is to obtain the measurement of the wall so that it can be used for excavation, concrete, footings, brickwork, damp-proof course, etc. To avoid measuring the corners twice, the measurements are taken from the centre line of one wall to the centre line of the wall opposite. The

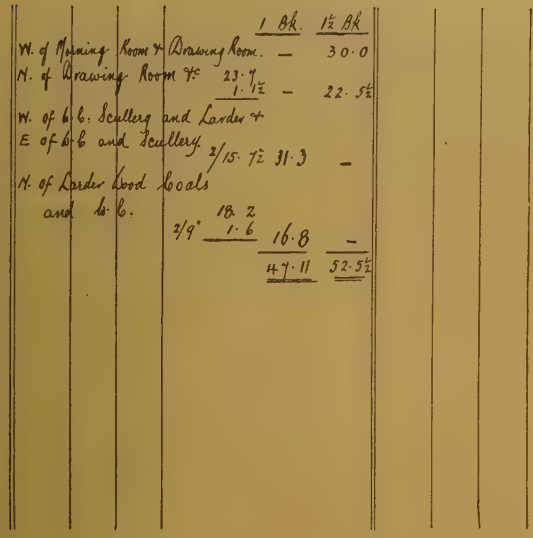

Fig. 20

same end, however, is attained by measuring one wall its full length and a wall at right angles to this from where it abuts against the first wall to its end. The other walls following round the building are then taken in the same manner, until the last wall is reached ; this will be measured in the clear. This latter is the method generally used and will be found much simpler than measuring along the centre lines. Work that is circular on plan should be measured through the centre lines. When the building is square, the full length of two walls and the length in the clear of the walls at right angles are measured.

EXAMPLE 1.—What are the wall measurements of a building that is 20 feet square in the clear and has walls 18 inches thick?

SOLUTION.—Measuring between centre lines, one wall is 20 ft. $+ \frac{18 \text{ in.} + 18 \text{ in.}}{2}$ = 21 ft. 6 in. long; the total length of the four walls is

21 ft. 6 in. × 4 = 86 ft. Ans.

Measuring the full lengths of two walls and the clear lengths of the walls at right angles to them, the length of wall is

2 × (20 ft. + 18 in. + 18 in.) + (2 × 20 ft.) = 86 ft. Ans.

EXAMPLE 2.—What are the wall measurements of the building shown in Fig. 21?

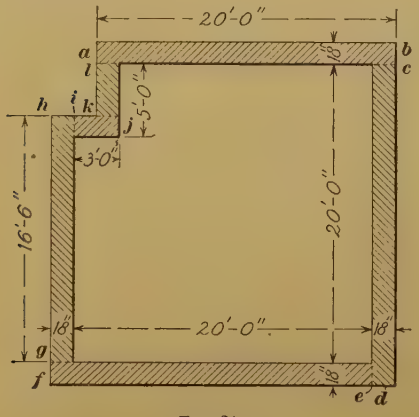

FIG. 21

SOLUTION.—Add together the lengths of the walls *a b*, *c d*, *e f*, *g h*, *i j*, and *k l*; or 20 ft. + (20 ft. + 18 in.) + (20 ft. + 18 in.) + 16 ft. 6 in. + 3 ft. + (5 ft. − 18 in.) = 86 ft. Ans.

EXAMPLE 3.—Take off the excavation, concrete, footings, damp-proof course, and brickwork up to the ground-floor line of the external walls shown in Fig. 22, where *a* is the ground-floor line, *b* is the damp-proof course, and *c* is the ground line. There is 47 feet 11 inches of 1-brick wall, shown in (*a*), and 52 feet $5\frac{1}{2}$ inches of the $1\frac{1}{2}$-brick wall, shown in (*b*). All the walls are laid in mortar. Allow for planking and strutting.

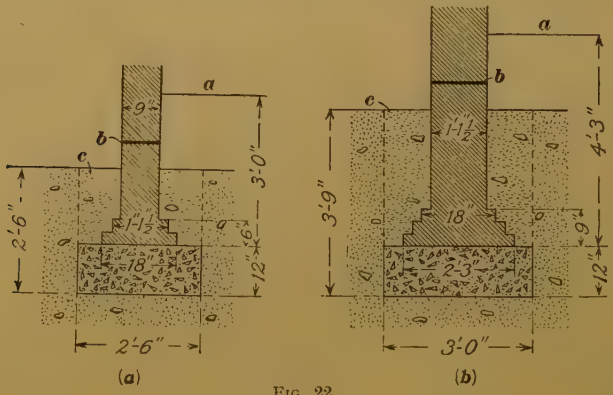

FIG. 22

Solution.—In cases like this the items in connection with the two thicknesses of wall should be taken conjointly. First take the excavation for the concrete, as the same dimension is also used for the concrete. In (*a*) the concrete has a length of 47 ft. 11 in., a width of 2 ft. 6 in., and a depth of 1 ft.; or 47 ft. 11 in. × 2 ft. 6 in. × 1 ft. = 119 ft. 10 in. cube. In (*b*) the concrete has a length of 52 ft. 6 in., a width of 3 ft., and a depth of 1 ft.; or 52 ft. 6 in. × 3 ft. × 1 ft. = 157 ft. 6 in. cube. The remainder of the excavation for the 1-brick wall is 47 ft. 11 in. × 2 ft. 6 in. × (2 ft. 6 in. − 1 ft.) = 179 ft. 8 in. cube. For the $1\frac{1}{2}$-brick wall it is 52 ft. 6 in. × 3 ft. × (3 ft. 9 in. − 1 ft.) = 433 ft. 2 in. cube. These dimensions are described as "return, fill in, and ram." The adjustment to the last dimensions for that portion displaced by footings and wall, and therefore carted away, is 47 ft. 11 in. × $\frac{1 \text{ ft. } 1\frac{1}{2} \text{ in.} + 1 \text{ ft. } 6 \text{ in.}}{2}$ × 6 in. = 31 ft. 11 in. cube, and 47 ft. 11 in. × 9 in. × [2 ft. 6 in. − (1 ft. + 6 in.)] = 35 ft. 11 in. cube for the 1-brick wall; and 52 ft. 6 in. × $\frac{1 \text{ ft. } 6 \text{ in.} + 2 \text{ ft. } 3 \text{ in.}}{2}$ × 9 in. = 75 ft. 6 in. cube, and 52 ft. 6 in. × 1 ft. $1\frac{1}{2}$ in. (called 1 ft. 2 in.) × [3 ft. 9 in. − (1 ft. + 9 in.)] = 122 ft. 6 in. cube. Planking and strutting will be obtained by taking the lengths as running dimensions and stating the width and depth.

The footings for the 1-brick wall are in two courses; the top is 1 ft. $1\frac{1}{2}$ in., which equals $1\frac{1}{2}$ bricks; the bottom is 1 ft. 6 in., which equals 2 bricks; these added together and divided by 2 give $\frac{1\frac{1}{2} + 2}{2}$ = $1\frac{3}{4}$ bricks, average. So the dimension for the footings is 47 ft. 11 in. × 6 in. = 24 ft. super. This is described as "$1\frac{3}{4}$-brick (avge.) foots." The ground floor is 3 ft. above the top of concrete; deduct from this the 6 in. for footings already taken and 2 ft. 6 in. is left as the height of the wall. So the dimension for the wall is 47 ft. 11 in. × 2 ft. 6 in. = 119 ft. 10 in. super. Footings for the $1\frac{1}{2}$-brick wall are taken next; they are shown in Fig. 22 (*b*). The footings being an average of $2\frac{1}{2}$ bricks, namely $\frac{2 + 3}{2}$, the dimension is 52 ft. 6 in. × 9 in. = 39 ft. 5 in. super. This latter is for three courses high; the wall above is 52 ft. 6 in. × (4 ft. 3 in. − 9 in.) = 183 ft. 9 in. super. The damp-proof course is 47 ft. 11 in. × 9 in. and 52 ft. 6 in. × 1 ft. $1\frac{1}{2}$ in. (called 1 ft. 2 in.). These measurements are entered on the dimension paper as shown in Fig. 23.

51. Exposed Concrete Bed and Footings.—In Fig. 24 is shown a section of an external wall in which part of the foundation concrete and all the footings are exposed. In taking off work like this, the surface or basement excavation should be measured out to the dotted line *a b*, and in depth to the under side of the

concrete. The hatched portion *c* is measured as returned, filled in, and rammed. Planking and strutting should be measured for

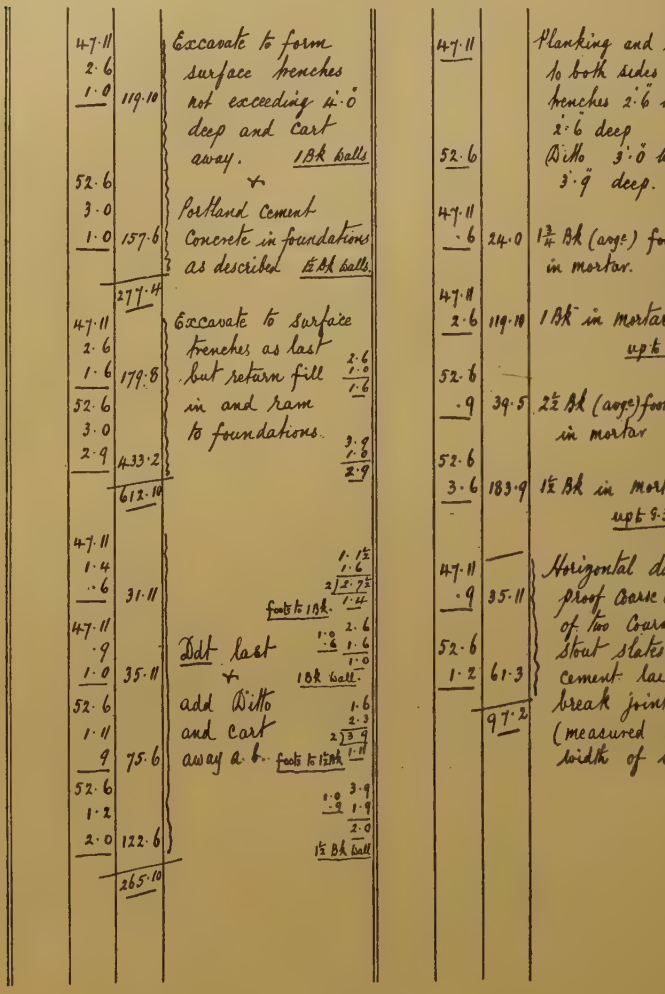
Excavate to form surface trenches not exceeding 4'0" deep and cart away. 1 Bk Walls
Portland Cement Concrete in foundations as described ½ Bk Walls
Excavate to surface trenches as last but return fill in and ram to foundations.
Ddt last
add Ditto and cart away a. b.
1 Bk Wall
Planking and strutting to both sides of trenches 2'6 wide & 2'6 deep
Ditto 3'0 wide & 3'9 deep.
1 Bk (arge) foots in mortar. to 1 Bk
1 Bk in mortar up to G.F. level
2½ Bk (arge) foots in mortar to 1½ Bk.
1½ Bk in mortar. up to G.F. level.
Horizontal damp proof Course Consisting of two Courses of Slate in cement laid to break joint. (measured net width of Wall)

Fig. 23

the height *a d*. Therefore, there will not be any excavation to trenches; but when taking the foundation concrete, an item of "temporary boarding and supports to foundation concrete

inches high " must be taken for the height *e f*, as the surface concrete is not laid until afterwards.

52. Piers and Breasts.—Projections usually have the same number of courses of footings as the adjacent wall and must always be so taken, unless otherwise shown. In some cases it is more convenient that the projection should be taken as the length. In taking off, the walls are first measured as though the projections did not exist, then the piers and breasts are taken and the necessary adjustments made.

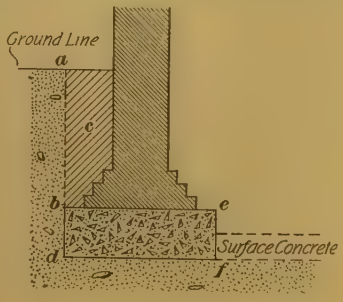

FIG. 24

EXAMPLE 1.—In Fig. 25 is shown a pier projecting beyond the face of a 14-inch external wall, which has the same section as is shown in Fig. 22 (*b*). Take off the additional excavation, concrete, footings, damp-proof course, and brickwork up to ground-floor line. The material is to be carted away and part kept, returned, filled in, and rammed. Allow for planking and strutting.

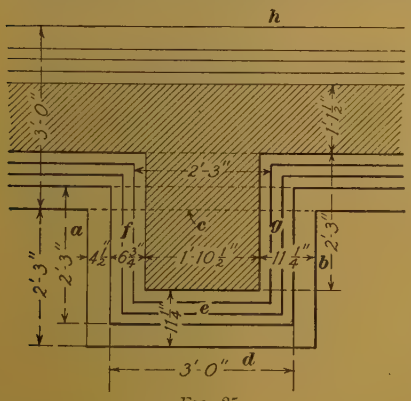

FIG. 25

SOLUTION. — The additional excavation is from the concrete bed of the wall to the end of the concrete bed of the pier and the full width of the pier; or the distances from *a* to *b* and from *c* to *d*, Fig. 25. As the thickness of the pier is 1 ft. $10\frac{1}{2}$ in., the distance from *a* to *b* is 1 ft. $10\frac{1}{2}$ in. + ($11\frac{1}{4}$ in. × 2) = 3 ft. 9 in. The distance from *c* to *d* is 2 ft. 3 in. Therefore, the material replaced by the concrete and that must be carted away is 3 ft. 9 in. × 2 ft. 3 in. × 1 ft. = 8 ft. 5 in. cube. The remainder of the excavation is 3 ft. 9 in. × 2 ft. 3 in. × 2 ft. 9 in. = 23 ft. 2 in. cube. The footings *f*, *g* contain $\frac{2 \text{ ft. } 3 \text{ in.} + 3 \text{ ft.}}{2} \times 2$ ft. 3 in. × 9 in. = 4 ft. 6 in. cube; the pier contains 1 ft. 11 in. × 2 ft. 3 in. × 2 ft. = 8 ft. 8 in. cube. Therefore, the amount that must be returned, filled in, and rammed is 23 ft. 2 in.

— (4 ft. 6 in. + 8 ft. 8 in.) = 10 ft. cube. Since the footings *e* are the same as the footings already measured for the walls, no adjustment is necessary for them.

From the planking and strutting taken with the main walls must be deducted the length from *a* to *b*, for it has not sufficient width; but the same length must be added with the width from *h* to *d*, which is 3 ft. + 2 ft. 3 in. = 5 ft. 3 in. Also planking and strutting must be taken for the sides of the pier excavation, which will have a length *d* to *c* of 2 ft. 3 in. and a width *a* to *b* of 3 ft. 9 in.

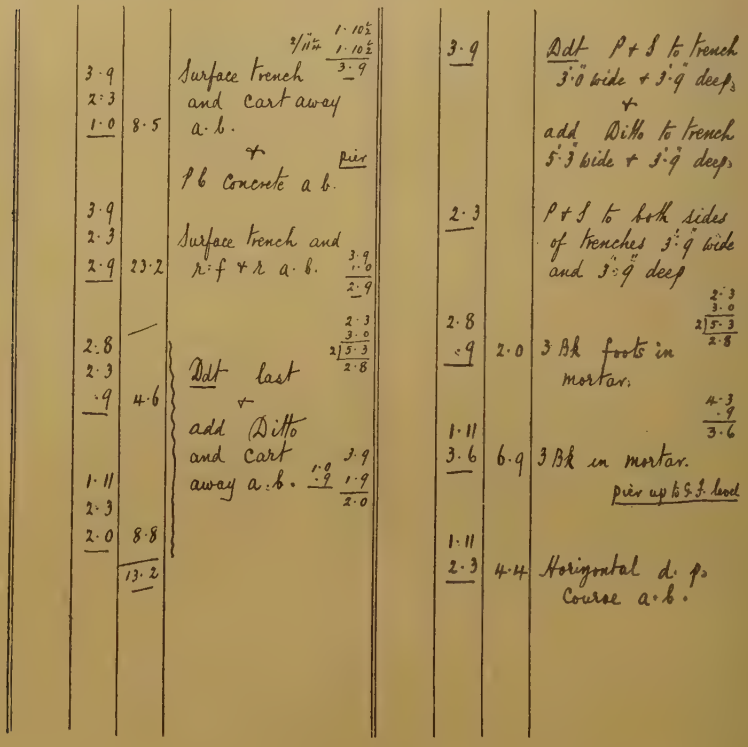
Surface trench and cart away a.b.
Pier
P & Concrete a.b.
Surface trench and P & R a.b.
Ddt last
add Ditto and cart away a.b.
Ddt P & S to trench 3'0 wide & 3'9 deep
add Ditto to trench 5'3 wide & 3'9 deep
P & S to both sides of trenches 3'9 wide and 3'9 deep
3 Bk foots in mortar.
3 Bk in mortar.
pier up to G.F. level
Horizontal d.p. Course a.b.

Fig. 26

The footings at *e*, Fig. 25, are equal to those displaced on the main wall, but footings at *f* and *g* must be taken. The length will be the average between the top and bottom, which is $\frac{2 \text{ ft. } 3 \text{ in.} + 3 \text{ ft.}}{2} = 2 \text{ ft. } 8 \text{ in.}$ The height of the three courses is 9 in. The thickness will be 2 ft. 3 in., or 3 bricks; that is, the net projection of pier. The pier will have a length of 1 ft. $10\frac{1}{2}$ in. by the height up to ground floor less that already taken

for footings; namely, 4 ft. 3 in. — 9 in. = 3 ft. 6 in. of 3-brick pier. The additional damp-proof course will be 1 ft. $10\frac{1}{2}$ in. × 2 ft. 3 in.

The taking off of this example will appear as in Fig. 26.

Example 2.—Fig. 27 shows the foundation for a breast in the angle between two 14-inch external walls; the section of the walls is the same as in Fig. 22 (*b*). Take off the additional excavation, concrete, footings, damp-proof course, and brickwork up to ground-floor line.

Solution.—The heights, or depths, are the same as used in example 1, so there is no need to repeat the way of arriving at them. The dotted lines show the work as it was taken with the external walls. First, the additional trench excavation must be taken; this resolves itself into a triangle *a b c* which has an area of $\frac{2 \times 2}{2}$ = 2 ft. super.; 2 × 1 = 2 ft. cube, which is therefore the dimension for trench excavation, carting, and concrete. It is also the dimension for the area of trench excavation, returned, filled in, and rammed. The adjustment from the last for the part carted away, in practice, would not be gone into very accurately. An examination of Fig. 27 shows that the footings taken with the main wall are in excess of what are actually wanted; therefore, the adjustment for these footings will be in excess also. But as the inaccuracy is very small and errs on the side of carting away, which is more expensive, this is not gone into, but the size of the angle breast, ignoring footings, is taken. This, in this case, is the triangle *e f g*, or $\frac{2 \text{ ft. } 6 \text{ in.} \times 2 \text{ ft. } 6 \text{ in.}}{2}$ × 2 ft. 9 in. = 8 ft. 7 in. cube. This dimension of course will be larger than the one that precedes it and from which it would appear the deduction is to be made, but really it is as much as an adjustment on the excavation to the main wall as on the item that precedes it. Planking and strutting are not adjusted for an item like this.

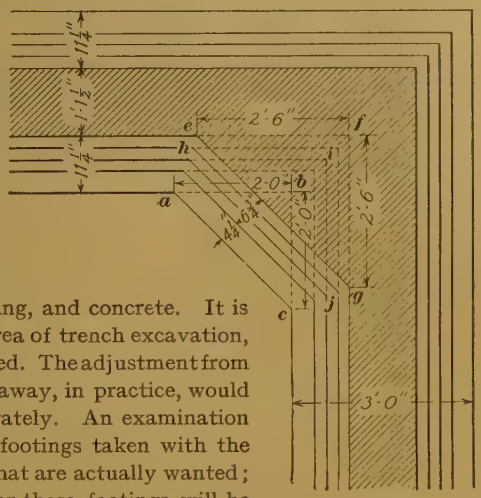

Fig. 27

Footings to a breast of this nature are a little awkward. It is best to deal with the projection of the footings and not the footing courses entirely. First find what has been previously taken with the main walls and is not wanted. Then deduct from this what is wanted for the breast and the remainder will be a deduction. To find what has been taken, measure along the centre line *h i* of the centre course of footings and

from *i* to *j*. In this case one length can be taken and multiplied by 2; 2 ft. 3 in. × 2 = 4 ft. 6 in. Then measure what is required for the breast; namely, the length from *h* to *j*, which can be taken as 3 ft. 3 in. Deducting 3 ft. 3 in. from 4 ft. 6 in. it will be found that 1 ft. 3 in. remains. Therefore, this will leave to be deducted a length of 1 ft. 3 in. by 9 in. a height of $\frac{1}{2}$ brick. The $\frac{1}{2}$ brick is found by taking the average of the projections; each projection is $2\frac{1}{4}$ in., or $\frac{1}{4}$ brick, so that the first is $\frac{1}{4}$ brick, the second $\frac{1}{2}$ brick, the third or bottom course $\frac{3}{4}$ brick. The average therefore is

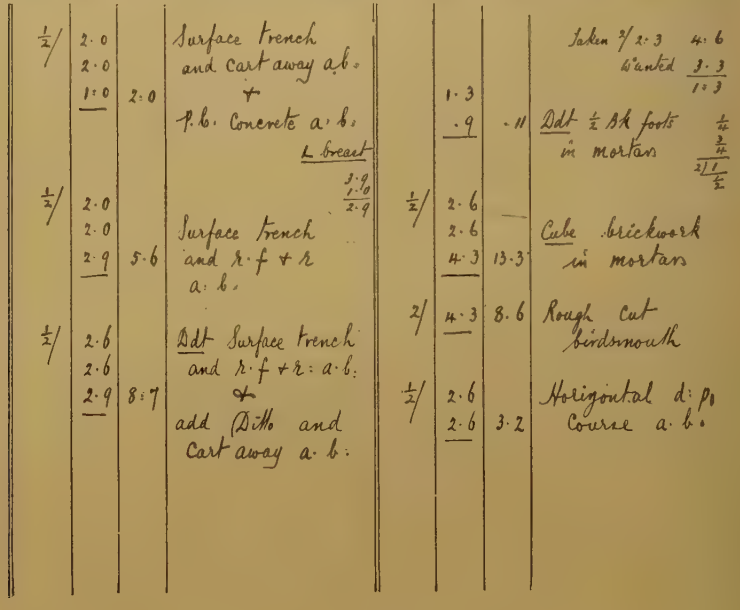
Surface trench and cart away a.b.
P.b. Concrete a.b.
L breast
Surface trench and r.f + r a.b.
Ddt Surface trench and r.f + r : a.b.
add Ditto and Cart away a.b.
Taken 3/ 2·3 4·6
Wanted 3·3
1·3
Ddt ½ Bk footg in mortar
Cube brickwork in mortar
Rough Cut birdsmouth
Horizontal d.p. Course a.b.

Fig. 28

$\frac{1}{2}$ brick. The breast itself must now be taken. This will be the triangle *e f g*; namely, $\frac{\text{2 ft. 6 in.} \times \text{2 ft. 6 in.}}{2}$ taken as a cube, because none of the dimensions are brick dimensions. The height is 4 ft. 3 in., which is from the top of the concrete to the floor level, as the projection only for footings has been previously dealt with. Rough-cut birdsmouth must be measured at points *e* and *g*; in each case this will be for the full height of 4 ft. 3 in. The damp-proof course will be of the same dimensions as the breast.

This example will appear on the dimension paper as in Fig. 28.

53. Internal Walls.—Make a collection of all internal walls of like thickness and proceed exactly as for external walls. It

is usual to deduct from the actual length of an internal wall for the excavation and concrete already taken with the external wall or other internal wall where the concrete is at the same level; but the overlap of the footings being very small, they are ignored and the footings taken the same length as the wall. For instance, in Fig. 29, *a* being an internal wall and *b* an external wall, the length of the internal wall is measured up to *c*; then, to arrive at the length for excavation and concrete to the internal wall, the measurement *d* must be deducted.

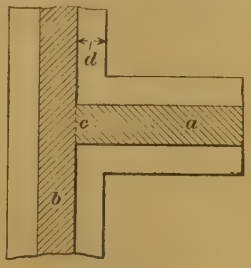

FIG. 29

EXAMPLE.—Take off the excavation, concrete, footings, damp-proof course, and brickwork up to the ground-floor line of the brick internal wall shown in Fig. 30. The internal wall *a* is 20 feet long in the clear between

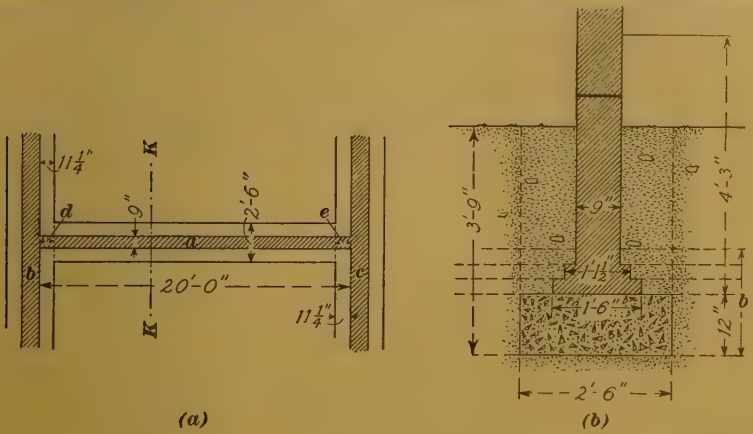

FIG. 30

the external wall *b* and the internal wall *c*, the concrete under all walls is at the same level and of the same thickness. In Fig. 30 at (*a*) is shown the plan and at (*b*) a section on the line *K K*. The wall *a* shown in (*a*) is taken to be an internal wall between a kitchen and a dining-room. The top of the concrete is 4 feet 3 inches below the ground-floor line as shown in (*b*).

SOLUTION.—This example is solved in exactly the same manner as those given for external walls, with the exception of obtaining the length of excavation and concrete. This is 20 ft. less the projection of concrete beyond the face of walls *b* and *c*, which is $11\frac{1}{4}$ in. to each wall, or 20 ft. $-$ ($11\frac{1}{4}$ in. $\times$ 2) $=$ 18 ft. $1\frac{1}{2}$ in. It must also be noticed that the adjustment for carting in lieu of returning must be the total length of the wall,

and the difference between 18 ft. $1\frac{1}{2}$ in. and 20 ft. is really an adjustment on the excavation to walls *b* and *c*. This adjustment is for the short lengths of walls at *d* and *e*, Fig. 30 (*a*). The taking off is as shown in Fig. 31.

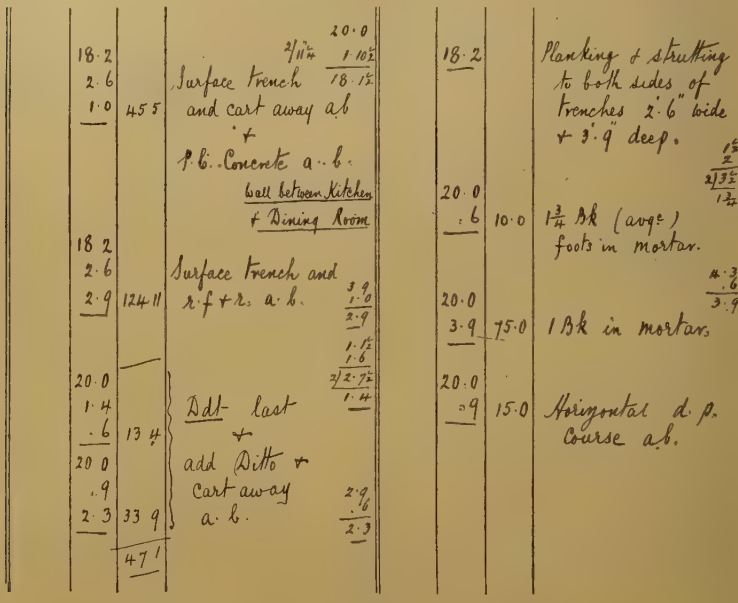
Surface trench and cart away a.b
P.C. Concrete a.b.
Wall between Kitchen & Dining Room
Surface trench and r.f.+r. a.b.
Ddl- last
add Ditto
Cart away a.b.
Planking & strutting to both sides of trenches 2'6" wide & 3'9" deep.
1½ BK (avge) foots in mortar.
1 Bk in mortar.
Horizontal d.p. Course a.b.

Fig. 31

54. Beam Filling.—Beam filling is measured per foot run, but the thickness of the wall must be given. If the brickwork has been measured up to the level *a*, Fig. 32, or halfway between *b* and *a* for a steep pitch roof, it should be described as "extra labour beam filling to -inch wall"; but if the brickwork has only been measured up to the level of *b*, it must be described as "labour and material beam filling to -inch wall."

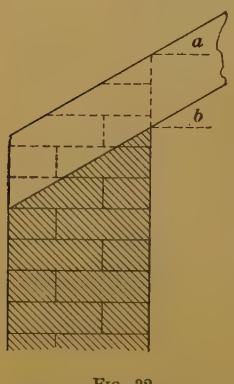

Fig. 32

55. Hoop-Iron Bond.—Hoop-iron bond is measured per yard run or per hundredweight. The size should always be given; also state whether tarred and sanded and that the price is to include laying in wall and lapping at joints.

It is customary to add 5 per cent. to the length for laps. One strand of hoop iron is generally required to every ½ brick in thickness of wall and about every four courses in height.

STONE WALLING

56. Method of Measurement.—There are three methods of using rubble for walling: (*a*) Walls built entirely of rubble; (*b*) rubble with a backing of brick bonded to the rubble; (*c*) rubble and brick with a cavity between. The method of measuring walls, however, varies considerably throughout Great Britain. In some districts walls are measured by the perch of 18 superficial feet reduced to a thickness of 2 feet; in others, by the rod of 36 superficial yards reduced to a thickness of 2 feet; and in others, by the perch of $16\frac{1}{2}$ superficial feet 18 inches thick. The superficial yard 24 inches thick is commonly used in the North of England. All walls that exceed this thickness are reduced to it, and those under that thickness are kept separate, according to their thickness. In some parts of Great Britain no deductions are made for openings. The London surveyor, however, measures rubble by the cubic yard, separating any walls under 18 inches thick according to their thickness.

57. Foundations.—Foundations are measured per yard cube. It should be stated if random, random coursed, or coursed, and if laid in mortar or cement.

58. Walling.—Generally, the best method of measuring walling is per yard cube; walls 18 inches thick and under should be kept separate and measured per yard superficial. All walling should be described fully as to foundations. Where only very thin brick backing is to be used, measure as "extra on the walling" per foot superficial. The Kentish rag rubble is mostly used in London and surrounding districts as a facing with thick brick backing; the full thickness should be measured as brickwork and the facing taken per foot superficial extra on the brickwork. The coursing and pointing to be used should be stated.

59. Levelling Up.—When taking the levelling up, measure per foot run, giving the width. An item for levelling up should be measured wherever a level bed is required for masonry, damp-proof courses, etc.

60. Internal Angles.—Where internal angles are to be *solid*, namely, a stone sunk or rabbeted out to form the angle, an item must be measured for the extra labour per foot run.

61. Facings.—Measure facings per foot superficial extra over the walling. They should be fully described, the average thickness, the number of through stones, the method of finishing, and the kind of mortar and pointing being given.

62. Dressings.—Where the stone used for dressings is the same as is used for the facing, measure as extra on the facing. Separate the jambs, strings, quoins, etc., and describe all labours on the stone. Make clear that the price is to include joints, beds, and all labours.

EXTERNAL FACINGS AND STONEWORK

63. Facings are generally measured, per foot superficial, as extra over the common or ordinary brickwork. The kind of bricks should be given, and, if special, the name and address of the manufacturer. It should be stated whether the work is to be "pointed with a neat-struck weather joint as the work proceeds," or "the joints raked out and pointed at completion with a neat-struck weather joint in cement," or any special pointing that may be specified. When the joints are to be raked out, any work that has been built in cement must be kept separate and described as "including raking out cement joints." Facings that are of better or different quality than the rest of the work, as the quoins of building or dressings to openings, are measured in the same way, but it should be stated in the description that they are in small quantities for quoins or dressings; facings to bands and other work in small quantities must likewise be separated.

An allowance of 3 inches is made in the height below the finished ground line or external paving. The height for all

facing must be a *brick dimension.* A course of brickwork is always considered as 3 inches, so that the height can never be such a value as 9 feet 5 inches or 9 feet 11 inches, but must be divisible by 3 inches without remainder, as 9 feet 6 inches or 10 feet. In measuring facings, collect the round of the walls that are of the same height and multiply by the total height from 3 inches below the finished ground line or external paving up to eaves, unless the plinth is in different bricks or some other feature prevents this. Generally, it is easy to find some general level from which to measure, and then any wants or extras can be taken later.

64. Brick Strings, Cornices, and Oversailing Courses.—All brick strings, cornices, and oversailing courses should be measured per foot run. The description should state whether the work is "extra over ordinary brickwork" or "extra over facing." When executed with the same bricks as the facing, the work is generally measured as extra over facing and the projection is measured as ordinary brickwork. If in cement, "extra only in cement" must be added and the length of the string, etc., measured and fully described, the mitres, etc., being numbered. If measured as "extra over ordinary brickwork," the projection is measured and the general facing displaced by the feature is deducted. The length of the string, etc., is measured and fully described and the mitres numbered. If the moulded courses are to be of a particular make, the catalogue number, the manufacturer's name and address, if not well known, should be given. Cement weather fillets on projecting courses should be measured per foot run, the widths being given and the mitres numbered.

65. Brick Plinths.—If the plinth is in a different brick from the general work, it should be kept separate and described as "in plinths." If the plinth is projecting, take per foot run the splayed or other course at top and number the angles and ends. When taking off projecting plinths, also measure the additional brickwork down on to the footings and the additional damp-proof course; also adjust the excavation, as the additional brickwork will cause some of the material that was taken as

being returned, filled in, and rammed to be added to the material that must be carted away. Care must be taken at the angles, when measuring plinths that project, as the facing is measured on the face, but the brickwork is a material item. This is shown in Fig. 33. The facing item is measured on the face to *a* and on the return from the same point, but the brickwork is measured on the face to *a* and the return is measured from *b*. This gives the same result as measuring on the centre line.

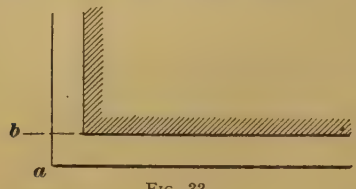

FIG. 33

66. Glazed-Brick Facings.—The foot superficial should be used for measuring glazed-brick facings. The colour should always be given, and it should be stated whether best or seconds are to be used ; if the bricks are to be obtained from a particular manufacturer, that fact must be stated. The method of pointing also should be described.

An allowance of $4\frac{1}{2}$ inches for cutting and waste is usually made at internal angles, but the better course is to take an item per foot run of "cutting and waste on glazed-brick facing at internal angles." Squints, birdsmouths, rakes, etc., are dealt with as in the case of general facings. Bull-nose or rounded angles are measured per foot run, the radius being given and all mitres and stops numbered.

Where glazed-brick facings are used internally, they are measured in exactly the same way, but are usually separated because of the pointing. All skirtings, band courses, etc., are kept separate. If there is to be a dado of glazed bricks with plaster above without a capping course between to *stop* the thickness of plaster, this facing must be described as "in dados, including extra labour and material, setting same forwards to be flush with plaster above."

EXAMPLE 1.—Take off the facing for the building that is shown on plan in Fig. 34 (*a*) and in section in (*b*). The plinth, which is shown hatched in (*b*), is to be in Staffordshire best blue bricks and the facing above the plinth is to be in best red pressed bricks. The height from the ground line, which is shown to be 1 foot 6 inches below the top of the plinth in

(*b*), to the eaves is 15 feet 6 inches. The wall is 1 foot $1\frac{1}{2}$ inches thick above the level of the plinth, and 1 foot $3\frac{3}{4}$ inches thick where the plinth occurs.

Solution.—To obtain the extra brickwork required for the plinth, take the extreme length of the two long sides *a*, *b*, Fig. 34 (*a*), and the length of the shorter sides *c*, *d*. Adding the thickness of the plinth at each end, the total length of the two long sides is [20 ft. + ($2\frac{1}{4}$ in. × 2)] × 2 = 40 ft. 9 in.; the total length of the two shorter sides is 16 ft. × 2 = 32 ft. Therefore, the total length is 40 ft. 9 in. + 32 ft. = 72 ft. 9 in. As the plinth rests on the top footing and extends 1 ft. 6 in.

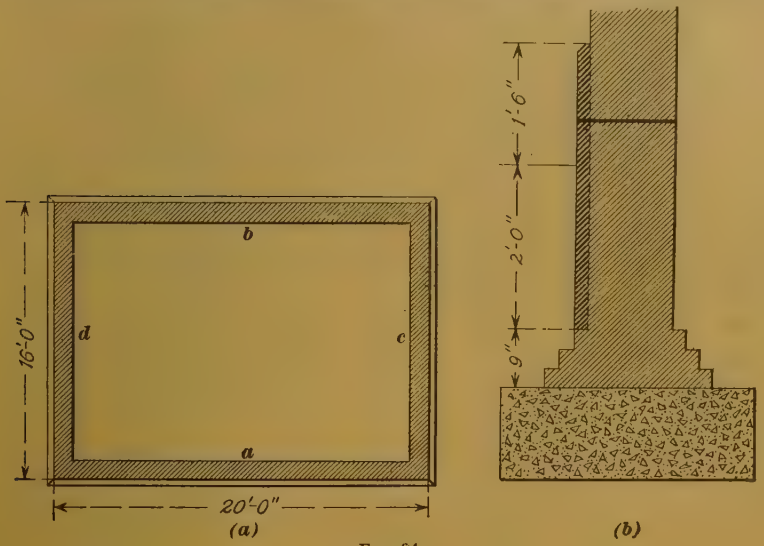

Fig. 34

above the ground its height is 1 ft. 6 in. + 2 ft. below the ground = 3 ft. 6 in. The dimension will therefore be 72 ft. 9 in. × 3 ft. 6 in.

The damp-proof course is 72 ft. 9 in. long and 2 in. wide. This width is found from the section Fig. 34 (*b*), where the total thickness of the wall, including the plinth, is 1 ft. $3\frac{3}{4}$ in.; but 1 ft. 2 in. has been taken for the $1\frac{1}{2}$-brick wall; therefore, only the additional width of $1\frac{3}{4}$ in., which is taken as 2 in., remains.

As the plinth reduces the amount of material that is to be returned, the measurement of "return, fill in, and ram" that was taken with the wall must be adjusted. The amount 72 ft. 9 in. × 2 in. × 2 ft. = 24 ft. 3 in. cube is deducted from the "return, fill in, and ram" and is added to the amount that must be carted away.

The facing to the plinth must next be taken. This is measured on the face or the extreme on all faces, and is easily done by adding twice $2\frac{1}{4}$ in.

to each of the dimensions given in view (*a*). The dimensions will therefore be [20 ft. + ($2\frac{1}{4}$ in. × 2)] × 2 = 40 ft. 9 in. and [16 ft. + ($2\frac{1}{4}$ in. × 2)] × 2 = 32 ft. 9 in. These two added together give 73 ft. 6 in., which will be the length; the height will be 1 ft. 9 in., made up of 1 ft. 6 in. above ground plus the allowance of 3 in. below the ground. This same length must also be taken for the splayed course at the top of the plinth, with

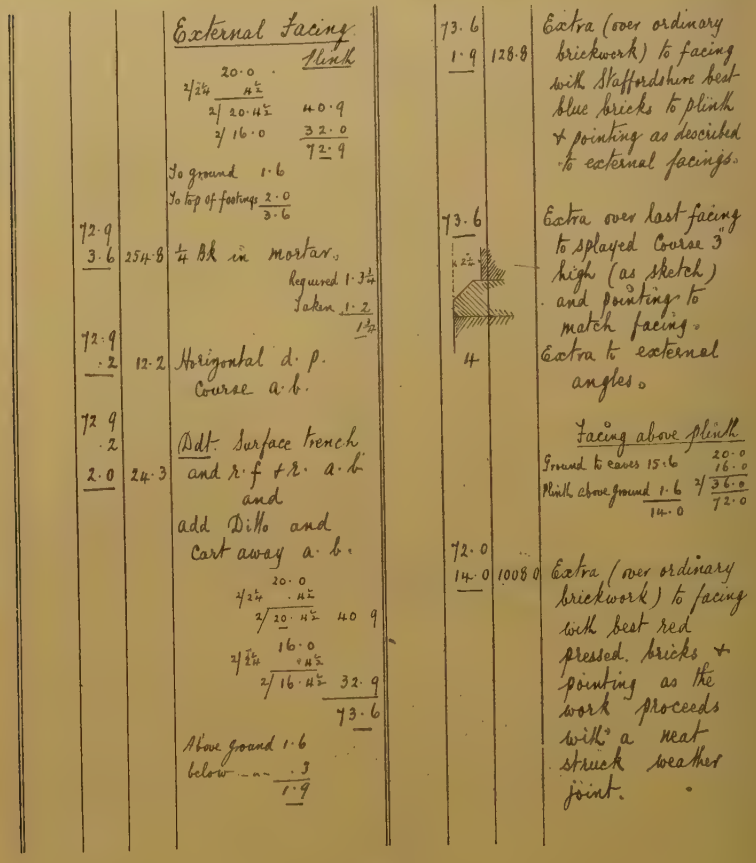

Fig. 35

four external angles. The facing above the plinth is the last item to be taken. The length is as shown in view (*a*), or (20 ft. + 16 ft.) × 2 = 72 ft. The height is given as 15 ft. 6 in. from the ground line to the eaves; but as 1 ft. 6 in. of this height has been taken with the plinth, the height of the facing above the plinth is 14 ft. This data will be entered on the dimension paper as shown in Fig. 35.

Example 2.—Take off the facing, above roof line, to the stack shown in Fig. 36, (*a*) being the plan and (*b*) the elevation, including the oversailing or corbelling courses that form the necking and cap.

Solution.—Take the facing first as if there were no projections. As the long sides are 2 ft. $7\frac{1}{2}$ in., they are entered on the dimension paper as 2 ft. 8 in. The height is the average between the two dimensions given (12 ft. + 9 ft. 6 in.) ÷ 2 = 10 ft. 9 in. The short sides are 1 ft. 6 in. long. One side will have the height of 12 ft. and the other the shorter height, 9 ft. 6 in. Next take the additional brickwork, beyond the ordinary stack, for the necking *a* and the cap *b*. For the necking, take

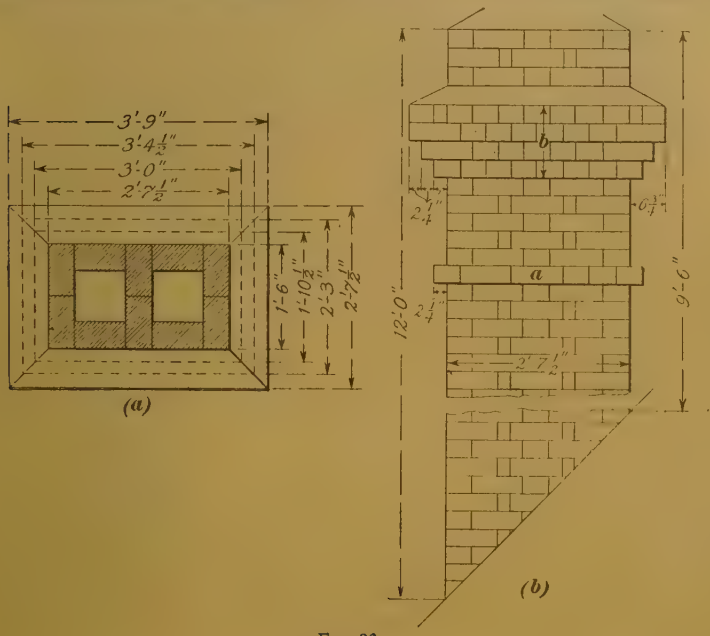

Fig. 36

the extreme length of the two long sides, or [2 ft. $7\frac{1}{2}$ in. + ($2\frac{1}{4}$ in. × 2)] × 2 = 6 ft., and the other two in the clear, or 1 ft. 6 in. × 2 = 3 ft. The necking is therefore 9 ft. As this is one course high, the girth must be supered by 3 in. and the projection, being $2\frac{1}{4}$ in., $\frac{1}{4}$ brick must be added. The first course of the cap is exactly the same as the necking. The second course is the same except that the projection is $4\frac{1}{2}$ in., so that the girth will be [2 ft. $7\frac{1}{2}$ in. + ($4\frac{1}{2}$ in. × 2)] × 2 + (1 ft. 6 in.) × 2 = 9 ft. 9 in.

The height is again 3 in. and the projection $\frac{1}{2}$ brick must be added. The top two courses must be taken in the same way, the projection being $6\frac{3}{4}$ in. This will equal $\frac{3}{4}$ brick that must be added.

Now deduct the facing for the necking and cap already taken in the first dimension and add what is actually needed. The girth of the stack is required for the deduction. This will be (2 ft. 8 in. + 1 ft. 6 in.) × 2 = 8 ft. 4 in. supered by the height of 3 in. for the necking and 1 ft. for the

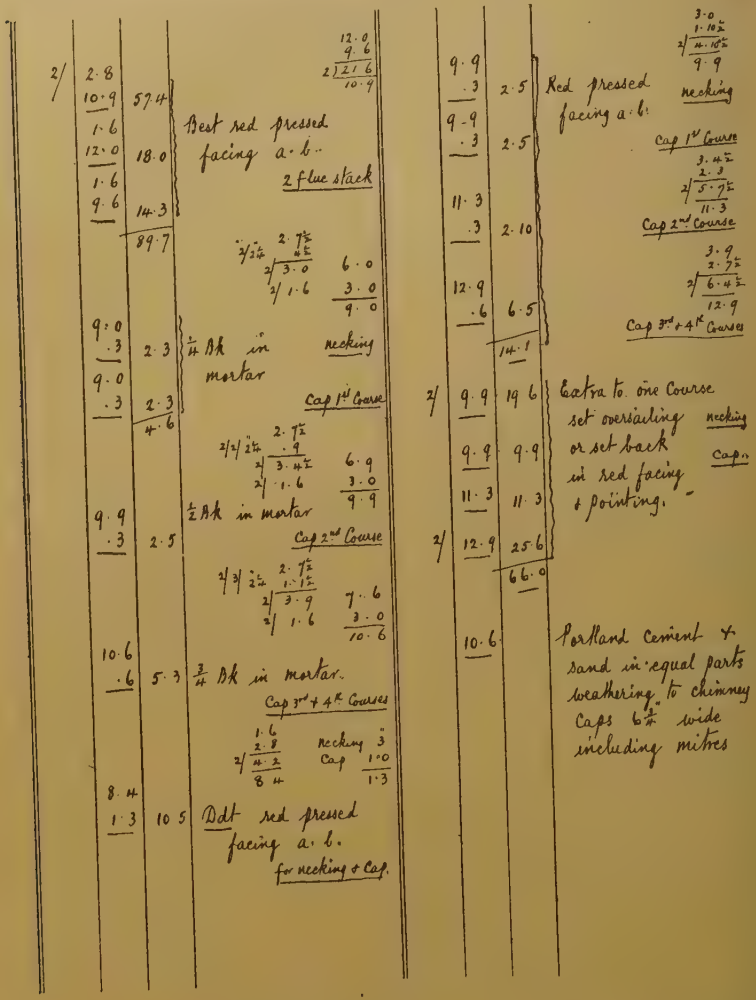
Best red pressed facing a. b.
2 flue stack
½ Bk in mortar
necking
Cap 1st Course
½ Bk in mortar
Cap 2nd Course
¾ Bk in mortar.
Cap 3rd + 4th Courses
necking 3
Cap 1·0
1·3
Bdt red pressed facing a. b. for necking & Cap.
Red pressed facing a. b.
necking
Cap 1st Course
Cap 2nd Course
Cap 3rd + 4th Courses
Extra to one Course set oversailing necking or set back Cap. in red facing & pointing.
Portland cement & sand in equal parts weathering to chimney Caps 6½" wide including mitres

Fig. 37

cap. The facing actually required for the necking and cap must now be measured. This, as already explained, must be taken on the face. The plan, Fig. 36 (*a*), shows that the necking is 3 ft. long one way and 1 ft. 10½ in. long the other; these added together and multiplied by 2 give

the girth, which will be supered by 3 in. The same dimension will do for the first course of the cap. The second course is (3 ft. $4\frac{1}{2}$ in. + 2 ft. 3 in.) × 2, and the third and fourth courses (3 ft. 9 in. + 2 ft. $7\frac{1}{2}$ in.) × 2, which will have to be supered by 6 in. for the two courses. Take the same dimensions per foot run for the oversailing. The length of the necking multiplied by 2 allows for setting back above the necking, as well as for oversailing, or setting forwards to form the necking; for a like reason, the length for the top course of the cap should be multiplied by 2. The last item required is the cement weathering to top of cap. This will be the length of the additional brickwork to the top course, [2 ft. $7\frac{1}{2}$ in. + ($6\frac{3}{4}$ in. × 2)] × 2 + (1 ft. 6 in. × 2) = 10 ft. 6 in. The work will be entered on the dimension paper as shown in Fig. 37.

67. Brick Copings. — *The foot run* is used for measuring brick copings. Where possible, they are taken as *extra over the facing*. A full description should be given and the thickness of wall must be stated. The description should include any weathering to offset double-tile creasing and weather fillets. Number the angles, irregular angles, ramps, fair ends, and coping irons.

68. Stone Copings.—When measuring stone copings, use the foot run. Give the width and thickness and describe all labours on same. Include in the description for all joints. Number all lead or iron cramps, including in the description the double mortises and running. These cramps should be about 3 feet apart, unless otherwise specified. Also number the fair ends, including in the description the return and mitres to throat, weathering, etc. Angle stones, springers, kneelers, bonders, finials, etc., can be taken either per number or per foot cube; in either case a full description must be given and more often than not a sketch also will be required. For this reason the former method is generally found the better, for then these items would be billed directly following the coping, and so give the estimator a much better idea of what the items include.

69. Vertical Tile Hanging.—The square of 100 feet superficial is used in measuring vertical tile hanging. The description should state the kind of tiles, whether or not ornamental, the gauge, the size of battens, whether or not plugged, and the method of fixing. Internal and external angle tiles should be

measured per foot run extra over the ordinary tiling, including cutting and waste and bonding on both sides.

Where necessary, take at per foot run at gables, etc., an item "Raking, cutting, and waste, on vertical tiling to skew abutments."

Measure the bottom edge or eaves per foot run, as "extra to eaves or bottom course to vertical tiling." If bedded and pointed in cement, this must be stated. Take at per foot run the tilting fillet or other course at the bottom to form the tilt.

All openings of 4 feet superficial, or over, must be deducted. The heads of openings will probably have the same finish as the bottom of the tiling, and will be dealt with as last directed. If some different method is used, the labour, etc., must be measured in the same way. Take an item per foot run to the sides and the bottom of all openings, and describe as "cutting and waste on vertical tiling to sides and bottom of openings."

70. External Rough Cast.—In taking off the external rough cast, measure per yard superficial and carefully describe not only the composition of the materials to be used, but also the method of operation, as this varies considerably with regard to the amount of labour entailed. Measure per foot superficial all work in narrow widths or in small quantities between half-timber work. Measure per foot run the brick, tile, or other course at eaves of rough cast, also an item for any extra labour and material forming the eaves in the rough cast material. Labour to arris should be measured per foot run.

71. External Cement Work.—State the thickness of external cement work, which is often termed *stucco* and is measured per yard superficial. All plain work in narrow widths or small quantities and weatherings and mouldings where 6 inches wide, or girth, and over, is measured per foot superficial. Where under 6 inches this work is measured per foot run together with narrow returns, arrises, throats, etc. All mitres and stops to weatherings and mouldings should be numbered. Any necessary brick oversailing courses or rough-stone cores for strings and cornices, and all necessary rough cutting to form chamfers, splays, etc., should be taken as they occur.

72. **Terra-Cotta.**—Generally, terra-cotta is measured per foot cube, but when it is 4 inches thick, or under, it is measured per foot superficial. Cornices, strings, friezes, cappings, and copings of small size are measured per foot run. Although most terra-cotta is *chambered*, that is, hollow, it is measured as solid. Generally, brickwork is not deducted for terra-cotta, but the description should state clearly whether it is or not. As a rule, the items that are measured per foot cube can be divided into plain work, moulded work, and enriched work.

The description should clearly state whether the terra-cotta is to come from any special manufacturer, its colour, and whether the colour is to be obtained by burning or artificial means; also state what is to be the general thickness and if blocks under a certain thickness are to be solid. The description must also state who is to supply the models for the plain, moulded, and enriched work. The models for the latter are generally dealt with as a provision for a modeller to execute. The material for filling the blocks and whether filled in before or after fixing should always be given. Include in the description an item for soaking in water a certain number of hours, hoisting, and setting, and state the kind and colour of mortar. If the building is over 40 feet high, keep separate all terra-cotta over that height, dividing it into sections of 20 feet each; these will then be described as 40 to 60 feet, 60 to 80 feet, etc. Also include in the description an item for casing up the work during erection and for cleaning down the whole at completion.

If a separate contract is entered into for the supply of the terra-cotta, the amount generally includes delivery on the job. The sum is entered as a prime-cost amount and the estimator has to add for assisting to unload, profit, filling the blocks, hoisting, and setting. The total amount in cubic feet should be given for this. Care must be taken to state who is responsible for errors in setting out, bonding, etc. Clean off reveals of terra-cotta door and window jambs to receive frames, and clean up and straighten grooves for lead lights, metal tongues, etc.; this work is measured per foot run. Number all ends cut and pinned to brickwork, also all notchings, cramps, dowels, and mortises.

73. Stonework.—There are three methods in common practice for measuring stonework: (*a*) Measure the cube stone and then take out all preparatory and finished labours thereon. (*b*) Measure the cube stone and include with same all preparatory labours; namely, half sawing and rough sunk; very often plain beds and joints are also included; and then take out all finished labours on the stone. (*c*) Measure the cube stone and include with same all labours of every description, fully describing the work on each stone.

For a stone-faced building the first method is most correct, but often all the labour expended on this system is not appreciated by the estimator; also, in many cases, the time allowed for the preparation of the quantities does not permit time being spent on labour that may not be appreciated in pricing. The second method, therefore, is used far more frequently and in many cases the third method is used entirely. It is advocated by some that, owing to the general use of machinery, stonework resolves itself into two classes: *ordinary* and *stopped work*, or *machine* and *hand work*. However, a safe plan is to use the second method for stone-faced buildings generally, and if time is short to include with the cube stone plain beds and joints. For buildings with occasional stone dressings the third method should be used.

74. In all cases, state how the face is finished, whether rubbed or dragged, etc., and also that it includes hoisting and setting. The height of each stone usually agrees with a certain number of brick courses; in neighbourhoods where the bricks rise more than 12 inches to the four courses, this must be carefully watched. Stone 3 inches thick and under and all plain ashlar is measured per foot superficial, the remainder per foot cube. Keep separate all stones which are in scantling lengths, namely, for most kinds of stone 6 feet long and over; for Mansfield 4 feet long and over is considered scantling. Keep separate all stones that must be hoisted over 40 feet, in heights of 20 feet, describing as 40 to 60 feet, etc. If desired, all like stone can be put together and a cube item taken for "extra hoisting stone exceeding 40 feet and not exceeding 60 feet."

State whether the stone is set and jointed in mortar or cement. Very often it will be found a better plan to take all stone as set in mortar, and then for the small portions set in cement take a cube item of "extra only for setting stone in cement in lieu of mortar as described."

75. Cube Stone.—Stone is measured the net size of a cube which will contain the stone when worked. To avoid claims for waste, etc., it is usual to state clearly in the bills "The stone is measured net as set in the work and no allowance has been made for waste." The rules of the Manchester Society of Architects allow 1 inch each way beyond the net dimensions of each block when worked. When the dimension of a stone measures out to the fraction of an inch, it should be taken to the next inch. Thus, a stone 1 foot $9\frac{1}{2}$ inches by $10\frac{1}{2}$ inches by 9 inches should be entered as 1 foot 10 inches by 11 inches by 9 inches. Brickwork and external facing must be deducted for stones which are 6 inches high and over; but this deduction is only for the part of the stone which is in the wall. The mistake of writing after an item of cube stone "and deduct brickwork" should be avoided when the stone is projecting beyond the face of the wall.

76. Labours.—All labours, except preparatory ones, are measured over the "finished surface exposed," except beds and joints. For these, one face measured represents the two faces necessary to form the bed or joint. Where the labours are less than 12 inches long, it is usual to keep them separate, and state "in short lengths." Labours to shafts of columns, pilasters, etc., must be kept separate where swelled and diminished.

77. Half Sawing.—The preparatory labour of half sawing is measured per foot superficial. It is the surface produced on a piece of stone after being sawn.

78. Stopped Work.—A labour is said to be **stopped** when it does not continue for the whole length of the stone; for instance, the weathering of a sill with *stoolings* for jambs or mullions, and the moulding on a jamb which stops on a splay.

A **stool** is a stop to a weathering, as on a stone sill which forms the square table, or stool, to receive the jambs. When labours are stopped, the price is considerably more; therefore, great care must be taken to write against each item "stopped."

79. Rough Sunk.—The preparatory labour of rough sunk is measured per foot superficial. Generally, if this is measured, the finished labour is not described as "sunk." Rough sunk must be taken, even though preparatory labours are not being measured, in all cases where it is not the preparation for a *finished labour;* that is, wherever the sinking is concealed.

80. Beds and Joints.—*Beds* and *joints* are finished labours, and should be measured per foot superficial. One bed and one joint on each stone should be measured and described as "one face measured for two." The bed should be the first two dimensions taken from the cube stone and the joint the last two. A **bed** is made up by the lower and upper surface of a stone coming in contact with a stone above or below it, the two touching surfaces forming two half beds. Therefore, when one bed is measured on each stone, it is really two half beds. A **joint** is where the side of a stone comes in contact with a stone adjoining.

Where a plain face occurs on a surface already taken as a half bed or joint, for instance, a quoin stone, the plain face should be measured, and the half joint or half bed deducted. Where joints are not shown on the drawings, such as in long lengths of strings and cornices, allow one in about every 3 feet. The beds and joints on stone in small scantlings, such as mullions and transoms, are usually measured as all beds and joints; that is, the full bed or joint is given to each face. Bed or joint is usually measured on two faces of a column; that is, on two faces of the square that will contain the column. This is a preparatory labour to the circular face.

Sunk beds and *joints*, *circular beds* and *joints*, and *circular sunk joints* should be kept separate and measured in full, not half. **Sunk beds and joints** are those that are sunk below the general surface of a rectangular block. **Circular beds and joints** are those sunk below the general surface of a rectangular block,

and are either concave or convex. **Circular sunk joints** are those which are sunk below the surface of a circular face; for instance, a rabbet in the soffit of an arch stone for the door frame.

81. Plain Face.—Plain face is measured per foot superficial on all four faces of mullions, and afterwards the finished face, whether moulded or sunk, is measured in addition. It is also measured to both faces of tracery heads. Where the face is 3 inches wide or under, it is measured per foot run, the width being given and the work described as "plain margin inches wide." The description should state if the face is rubbed or dragged, etc.

82. Circular Work.—All circular work is measured per foot superficial, such as the convex surface of the shaft of a column.

83. Circular-Circular Work.—The convex surfaces of spheres and domes are known as circular-circular work, and are measured per foot superficial.

84. Sunk Work.—Measure per foot superficial all **sunk work**; this is work to a plain face sunk below the surface of a rectangular block. Where 3 inches wide, or under, measure per foot run, giving the width, and describe as "sunk margin inches wide." Where the girth is 6 inches or under, measure per foot run, giving the girth, and describe as "rabbet inches

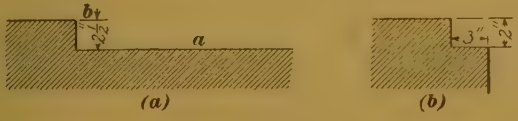

Fig. 38

girth." A sunk face should be measured as shown at *a*, Fig. 38 (*a*); a sunk margin $2\frac{1}{2}$ inches wide, as shown at *b*; and a sunk rabbet 5-inch girth, as shown in Fig. 38 (*b*). Circular sunk work is kept separate; it includes such concave surfaces as soffits of arches. Circular-circular sunk work includes such concave surfaces as domes.

85. Moulded Work. — Where its girth exceeds 6 inches, moulded work is measured per foot superficial. Where the girth is 6 inches or less, measure per foot run, giving the girth. Where 9 inches long or under, describe as "in short lengths." The length of moulding that has external mitres must be measured the extreme length along the nib of the moulding. Circular moulded work must be separated; moulded work to circular bases and caps is described as "circular continuous."

86. Throats and Chamfers. — The following items are measured per foot run: throats; mitres to splay, if over 12 inches wide; chamfers not exceeding 3 inches wide, giving the width; joggles, stating the kind or the number, giving the average girth, and including the running with cement or other material; groove or rabbet for lead lights and pointing; groove for metal tongue; and groove for flashings and burning in. Number all mitres and stops to the foregoing, in addition to describing the respective items as "stopped."

87. Mitres and Stops.—Take according to their number all stopped ends, stops and mitres to weatherings, sinkings, mouldings, etc., giving the girth in each case and stating if on splay or irregular. Also take all perforations, stating whether rough or fair, mortises and running, and lead plugs and mortises. Give the size of dowels and state whether iron, slate, or copper, and include with each its mortises and running. In the case of cramps, give the size and state whether iron or copper, and include their mortises and running.

88. Bases and Corbels.—Take according to their number all small bases, corbels, etc. Give their sizes and describe fully all labours on them.

89. Casing Up.—Take an item for casing up and protecting all stonework during the execution of the works and clearing away on completion; also for cleaning down and pointing as the work proceeds and on completion.

90. Boasting for Carving.—Boasting for carving is measured per foot superficial, per foot run, or according to their number, depending on the feature to be carved. The labour is really

rough sunk, but must include for stopping all mouldings up to carving after the carver is finished.

91. Carving.—The usual method is to provide a sum for carving and modelling, as the value depends so much on the skill of the workmen and the requirements of the architect. Carefully discriminate between what is ordinary mason's work and what is carving. The mason will do all work, however intricate, except where it is enriched. When a provisional amount is included, there must be an item following the provision allowing for profit, attending on carver, and affording him the use of all scaffolding and plant he may require, altering and shifting same from time to time as may be directed by him, and providing any covers, cloths, hoarding, or enclosures, and removing and clearing away same when directed.

92. Lead Coverings.—Measure per foot superficial all lead coverings, and describe the weight per foot. Afterwards reduce and bill in hundredweights, quarters, and pounds. To the net length of stone cornices, etc., that must be covered, add the additional gain for the welted joints. The width will be the measurement on the splay of the cornice plus the turn down over edge and the turn up at back. The lead at the back is either turned into the blocking course or brickwork, or a separate cover flashing is put as to gutters. Measure per foot run all extra labour for turning lead over edge of cornice, stating the weight of lead and numbering the mitres; also the labour for welted joints, stating the weight of lead, and for grooving and burning in or raking out joints, wedging and pointing at the back. Take according to number the lead dovetailed plugs and mortises for fixing.

93. Granite.—The measurement of granite is exactly the same as for other stone, except that all beds and joints are measured instead of one for two. Be careful to state in the description if from any special quarry, and whether it is to be rough picked, fine picked, axed, fine axed, etc., on face. Polishing is measured per foot superficial. When in any quantity, it is much better to have this work carried out by a granite

merchant, and a sum included as a provision. In this case, state clearly whether the granite merchant or the builder is to unload, get in, hoist and fix, protect, clean down, and point.

COAL SHOOTS

94. Excavation.—The excavation, concrete, footings, brickwork, damp-proof course, and facing to sides of coal shoots will be measured exactly the same as for other parts of a building.

95. Opening in Main Wall.—The opening for a coal shoot in the main wall, with the adjustment of facing both sides and the arch or lintel over, is exactly the same as for ordinary openings.

96. Bottoms.—The bottoms of coal shoots are usually sloping, although sometimes the floor is at the same level as the coal cellar. If the former, they are usually formed of a slab of stone bedded on concrete or broken brick. Measure the broken brick and concrete, if the average thickness is over 12 inches, per foot cube. If 12 inches or under they should be measured per foot superficial, stating it is "in small quantities to form slope." The stone slabs should be measured per foot superficial, giving the thickness and stating whether self-faced or tooled. Measure per foot run the exposed edges as "labour tooled edge on -inch stone." The edges in the wall will be measured per foot run as "cutting and pinning in cement edge of -inch stone on rake to brickwork."

If the bottoms are of concrete with cement finish, the concrete should be measured as before and the cement finish per foot superficial. The composition and the thickness should be given; for instance, "Portland cement and sand in equal parts, trowelled hard and smooth, as finish to sloping bottoms of coal shoots 1 inch thick."

97. Tops.—The stone tops of coal shoots should be measured per foot superficial, stating the thickness and whether rubbed or tooled on one or both sides; the description must include for jointed edges. See that the stones are taken large enough

to rest on the enclosing walls and for going into the main walls, if they are to do so. If necessary, take cutting and pinning of edges to brickwork. Take according to number the perforations for coal plates and frames, and describe as "rabbeted perforations in -inch stone for -inch diameter coal plates and frames."

98. Coal Plates and Frames. — Take the coal plates and frames according to number, giving, for preference, the maker's name and catalogue number. Also state the size, and include in description for "setting the frame in cement to rabbet in stone, measured separately." The painting should be taken according to number, stating the size and that it is on "both sides"; if the coal plates are illuminating, mention it.

AREAS AND LIGHT WELLS

99. Excavation.—For areas and light wells, take the excavation, concrete, footings, brickwork, damp-proof course, and facing to sides exactly as described for other parts of a building.

100. Curbs.—Stone curbs should be measured per foot run, stating the width and thickness, whether tooled or rubbed, and any labours in the shape of chamfers, roundings, etc. The description should also include all jointed ends. Take according to number all fair ends, angles, ends cut and pinned to brickwork, cramps, dowels, etc.

101. Steps.—The steps for area and light wells, whether of stone or concrete, should be measured as the steps in an ordinary stone or concrete staircase.

102. Pavement and Stallboard Lights.—If there are a number of pavement and stallboard lights, they should be measured per foot superficial; if there is only one or two, they should be measured according to number. The description should give the maker's name, the section of frame and lenses, and whether of stock sizes or not. The painting is measured per yard superficial, and should be separated from ordinary yard work, and the description should state that it is on "both sides."

Measure per foot run the rabbet in the stone curb, etc., for edge of pavement light ; separate any work that is stopped.

103. Grilles.—The several bars, rods, etc., of grilles should be taken per foot run and afterwards reduced and billed in hundredweights, quarters, and pounds. A full description of what the grilles consist should be given, and they should be described as " framed." In measuring the several bars, care must be taken to allow sufficient for the framing and for any ends mortised to stone or caulked ends in wall. For instance, in measuring upright bars that are framed at top and bottom into horizontal rails, allow for the bars going completely through the horizontal rails. Caulked ends and any special forgings in the shape of bends, ramps, wreaths, scrolls, etc., must be taken according to number. The painting is measured per foot run and described as " bar, rod, etc." Take according to number the caulked ends that must be cut and pinned to brickwork, and state what facing must be made good. Also take any ends mortised to stone, and describe for what size of bar or rail the mortises are, and whether the mortises are to be run with cement, lead, or sulphur.

104. Railings.—If the railings are of cast iron, they should be measured per foot run. The description should state the maker's name and the reference number of the design. In some cases it may be more convenient to allow a price as a provision per foot run. If of wrought iron, the railings should be treated the same as the grilles. Painting on railings should be measured per yard superficial or per foot run, the height being given and the fact stated that it is on " both sides."

FIRES

105. Fireplace openings that are on the same floor and are alike, except in width, can be averaged. Care must be taken that every fireplace has a flue shown on the plan of the next floor, and so on until the roof plan is reached; also that the stacks are large enough to take the number of flues required. In taking each opening, see that the breast has been taken to

a sufficient projection to allow, after deducting the opening, of leaving a brick back at least 9 inches thick ; also that the width of breast is sufficient to take the width of opening figured and to accommodate the number of flues required at sides of the opening.

106. Openings.—Deduct brickwork for the net width of all openings by the height up to springing of arch. The openings for ordinary stoves vary greatly in width from 1 foot 6 inches ; but they are generally 3 feet high and 14 inches deep, so that the deduction will be $1\frac{1}{2}$ bricks. The openings for ranges vary in width from 3 feet 6 inches, and also in height from about 4 feet 6 inches ; they are generally 1 foot $10\frac{1}{2}$ inches deep, so that the deduction will be $2\frac{1}{2}$ bricks. Plastering or other wall finish is not generally deducted, as it is considered that the value of the material not deducted equals the cost of making good to chimneypiece. If the plastering is deducted, an item for each must be taken of "making good plastering to chimneypiece."

107. Chimney Bars.—Chimney bars are measured per foot run, but are reduced and billed in hundredweights, quarters, and pounds. The size should be stated and the bars described as "cambered chimney bars caulked up and down at ends and building in by bricklayer." The general way of arriving at the length of bar is to take the width of the opening and add 2 feet, which is an allowance for the camber of the soffit of the arch and for the caulked ends which go into the brick jambs.

108. Relieving Arches.—Relieving arches over chimney bars are taken by number. The width of opening should be given and whether in one 1-brick ring or two $\frac{1}{2}$-brick rings. If in cement, it must be so described. As the arches are always $4\frac{1}{2}$ inches on soffit, it is not generally necessary to state this fact. The description will be "extra to rough relieving arches over fireplace openings average feet inches wide in two $\frac{1}{2}$-brick rings in cement including all cuttings." Centring is not required to these arches as the chimney bars do this work.

109. Fender Walls.—Measure fender walls per foot superficial in the same manner as ordinary brick walls that have footings.

These walls are usually built off the surface concrete, the overall size of the fender walls being the size of the front hearth, unless the fender walls are also carrying floor joists. When only $\frac{1}{2}$ brick, or $4\frac{1}{2}$ inches, thick, they should be separated and described as "fender walls," stating whether in mortar or cement. The footings are added to the ordinary brickwork, and if in cement the "extra only" is taken. When 1 brick, 9 inches, thick, the fender walls are not separated, but taken together with any footings and added to the ordinary brickwork.

110. Filling In to Fender Walls.—The filling in to fender walls must be taken off by number, stating whether in concrete or hard dry rubbish; the average size and depth must be given, and also the fact that the filling is levelled on top to receive the hearths. If the hearths are to be finished in cement a certain part of the filling must be in concrete; in that case, if the depth is not very great, it is better to have all the filling of concrete.

111. Trimmer Arches.—Take per foot superficial all trimmer arches and describe them as "$\frac{1}{2}$-brick trimmer arches in cement." The length will be the same as the front hearth; the width also is the same as the width of the hearth, except that 3 inches is allowed for the extra girth of the arch over the flat.

112. Centring to Trimmer Arches.—The centring to trimmer arches is measured per foot superficial, and would have the same dimensions as the trimmer arches. If the ceiling underneath is plastered, describe the centring as "left in and furred down for lathing to."

113. Skew-Back Cutting and Feather-Edged Springers.—Skew-back cutting is for the springing of the trimmer arch off the main wall. It should be taken the same length as the arch and supered by 5 inches as "rough cutting." The feather-edged springers are measured per foot run and are the same length as the arch.

114. Levelling Top of Trimmer Arches.—Levelling up on top of trimmer arches to receive the hearths should be measured per foot superficial. The dimensions are the exact size of the front

hearth. Be careful to describe that this work must be done with fine concrete. Sometimes the levelling is taken per number, the average size being given.

115. Hearths.—Measure per foot superficial and state the thickness of all hearths. The length of front hearths will be the width of fireplace opening plus 12 or 18 inches ; that is, 6 or 9 inches each side according to specification. The width, unless otherwise described, should be taken as 18 inches for ordinary stoves and as 24 inches for ranges. The length of back hearths will be the width of fireplace opening and the width will be the depth of the opening. If the front and back hearths are of the same material, they need not be separated ; but when in stone, the front is usually rubbed and the back tooled. Describe the stone hearths as "including jointed edges and notched, if required for chimneypieces."

116. Tile Hearths.—Tile hearths are usually included in the provision for stoves, etc., but if not, the hearths should be measured as just directed, fully described, and include setting in cement and necessary floated bed for same. Where included in the provision, take an item per foot superficial of "setting only tile hearths in cement on and including necessary floated bed for same."

117. Curbs.—If to be provided, curbs will be either in stone or marble. They should be measured per foot run, the size given, and all labours on same described. The length will be the girth of the outer edge of the front hearth plus the gain at the angles, which will be the width of the curb. For instance, if a front hearth is 3 feet long and 1 foot 6 inches wide with a curb 3 inches wide, the length of the curb will be 3 feet + (1 foot 6 inches × 2) + (3 inches × 2) = 6 feet 6 inches. Take by number the jointed ends against the chimneypieces and the extra for external angles ; the latter should include dowels.

118. Rendering, and Flues Parged and Cored.—Chimney backs are usually rendered in lime-and-hair mortar ; they should be taken off by number. Rendering over ranges should be taken off by number and described as "rendering over ranges

smooth in cement." Flues parged and cored should be taken by number.

119. Chimney Pots.—Take off by number all chimney pots, state the material and height, or give the maker's name and catalogue number; or provide a sum for each, stating in all cases that they are "set and flaunched up with plain tiles and cement."

120. Stoves and Ranges. — The best plan is to allow a provisional amount for all stoves and ranges. If, however, this is not done, carefully give the maker's name and the catalogue number; also give the width and height and the size of fire. Where a provisional sum is included, state what the provision includes, how many stoves, ranges, chimneypieces, tile hearths, etc. To this provision, the estimator must add for profit, packing, carriage, and delivery, and for returning the packing cases, carriage paid.

121. Setting Stoves and Ranges.—The setting of stoves and ranges must be taken off by number, the width of opening being always given. Where all are of the same kind, an average width can be given. State in the description "including all firebricks in fireclay and other materials." Keep separate combined stoves and chimneypieces, stoves with tiled cheeks, fire-on-the-hearth stoves, and well-fires.

122. Black Stoves and Ranges. — The item for blacking stoves and ranges is taken by number. The ranges should be kept separate and described as "and clean and polish bright parts."

123. Chimneypieces.—If chimneypieces are included in the provisional amount, an item per number must be taken for "fixing only chimneypieces to openings feet inches wide, including all necessary cramps, dowels, etc." If in stone, slate, or cement, take each chimneypiece by number and fully describe it, giving the opening and the width of jambs and mantel complete. If in wood, describe fully the mouldings, etc., and state that they are "to detail." The painting of chimneypieces is taken by number.

124. Ventilators in Breasts or Flues.—Take off all ventilators in breasts or flues by number. Describe the size and the material, and include forming the short horizontal flue into the vertical flue. If in iron and not galvanized, painting must be taken by number.

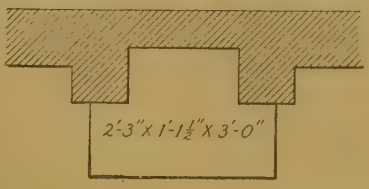

FIG. 39

EXAMPLE.—Take off the fireplace shown in Fig. 39, which is on an upper deal floor. The chimney bar is to be wrought iron, 2 inches by $\frac{1}{2}$ inch, with rough relieving arch over in two $\frac{1}{2}$-brick rings in cement. The hearths are to be York stone 2 inches thick, the back hearth tooled and the front rubbed. The stove with tile cheeks and the chimneypiece are assumed to be included in a provisional sum; curb is not to be measured.

SOLUTION.—The taking off of this fireplace is as given in Fig. 40.

COPPERS

125. Coppers and Setting.—Coppers should be numbered. The description should state whether they are made of galvanized iron or copper and the number of gallons capacity; it should also include all iron furnace work and door; also for setting solid in hard bricks in cement, forming flue, and rendering the outside and on top in cement and sand finished hard and smooth; also all arrises. An item should be inserted for blacking all furnace work and the door, which will be taken by number for the set.

126. Copper Lids.—Describe all copper lids by number, stating the thickness of wood and diameter; if in two thicknesses, the layers must be fastened with oak pins. Describe the handle, and whether fastened with oak pins or with copper screws.

127. Soot Doors.—Soot doors and frames are described by number. The description should give the size, whether single or double, and include for building in. Blacking the soot doors and frames is also numbered.

			Fires.
2·3			
3·0	6·9		Bdt 1½ Bk in mortar.
		2·3	
		2·0	
4·3			2"×½" bs 1 in cambered chimney bar caulked up & down at ends & building in by Bricklayer
1			Extra to rough relieving arch over fireplace opening 2'·3 wide in two half brick rings in cement including all cuttings.
		1·6	
		·3	
3·9		1·9	
1·9	6·7		Half brick trimmer arch in Cement.
			&
			centring to trimmer arch left in & fitted down for lathing to.
3·9			
·5	1·7		Rough Cutting.
3·9			feather edged springer
3·9			Levelling up on top
1·6	5·8		of trimmer arch with fine Concrete to receive hearth
2·3			
1·2	2·8		2" York stone. tooled back hearth including jointed edges.
3·9			
1·6	5·8		2" York stone rubbed front hearth including jointed edges & notched if required for chimney piece.
1			Render chimney back in lime & hair mortar
			&
			flue parge & Core
			&
			Terra Cotta chimney pot 18" high set & flaunched up with plain tiles & Cement
			&
			Setting only stove with tile cheeks to 2'·3 opening including all firebricks in fireclay & other materials.
			&
			Two Coats of Brunswick black on stove.
			&
			Fixing only Chimney piece to 2'·3 opening including all necessary dowels cramps &c
			&
			Four oils on Chimney piece.

EXTERNAL PAVINGS

128. Excavation. — Where excavation is required for the external pavings, it should be measured exactly as described for excavation over surface.

129. Broken-Brick or Ballast Filling.—Where 12 inches deep and under, broken-brick or ballast filling is measured per yard superficial, stating the depth; where over 12 inches deep, it is measured per yard cube. Describe the material and state whether of hard dry broken brick or stone, etc. Also include for filling in, levelling, and well ramming, and for levelling and ramming the ground underneath.

130. Concrete Beds.—Measure concrete beds per yard superficial, giving the thickness and composition. Describe as "spread and levelled." If laid to falls, the fact must be stated. If there is no rubbish filling underneath, include in description for levelling and ramming ground under.

131. Pavings.—All pavings, except stone, are measured per yard superficial; stone pavings are measured per foot superficial. Give the thickness and fully describe. If from a particular manufacturer, give name, address, and any special catalogue reference number or mark. If laid to falls, the fact must be stated. Describe the method of laying and jointing. If tile or brick paving is to be laid herringbone pattern, state that the paving must include for "straight cutting and waste." Very often a prime-cost sum per yard is included for pavings which are to be laid by a definite manufacturer.

132. Cuttings on Pavings.—All raking and circular cuttings on pavings, such as brick or tile, must be measured per foot run as "raking, cutting, and waste" or "circular cutting and waste."

133. Floated Beds for Pavings.—Certain pavings, such as asphalt and tile, require a floated bed in cement on top of the concrete; measure this per yard superficial, and state the thickness, composition, and whether to falls or not.

SOLID BASEMENT FLOORS OR GROUND FLOORS WITHOUT BASEMENT

134. Excavation, Filling, and Concrete.—The excavation over surface or to form basement is usually measured sufficiently deep to take the floor, but this should be only to the under side of the thinnest floor. In the case of a thick floor, extra excavation is required; this is taken off as directed for and added to excavation over surface. Brick or stone filling, concrete beds, floors, cuttings, etc., are measured in the manner already described.

135. Wood-Block Floors.—Wood-block floors are measured per yard superficial. The description should state the thickness, kind of wood, manner of laying, and if bordered. It should also include all straight cutting and waste next walls, etc., and for cleaning off at completion. Take per foot run all raking or circular cutting and waste. The patent blocks should be laid by the patentee and are best treated as a provision; the estimator must add for profit and attendance. If a provisional amount is named, make certain that it includes borders, if any, straight cuttings, etc. All wood-block floors need a floated bed on top of the concrete.

HOLLOW BASEMENT FLOORS OR GROUND FLOORS WITHOUT BASEMENT

136. Sleeper Walls.—The sleeper walls generally should be measured the same as fender walls. If built honeycomb, the fact must be stated. They are usually not more than 6 feet apart. Sleeper walls against main walls should be dealt with the same as brick plinths. In measuring, the height must be taken to the top of the plate to allow for bedding.

137. Carpenters' Work.—The general difference between carpenters' and joiners' work is that the former is usually prepared and fixed at the building, but the latter is brought to the building ready to fix, having been prepared at the bench. Unless otherwise stated in the specification, the specified sizes of timber are understood to mean those sizes minus the waste

caused by the sawing. When the sizes specified are to be "finished sizes," the fact must be specially mentioned in the bill, and an item inserted that no allowance has been made for waste in sawing. When the work is to be "wrought and finished sizes," care must be taken in work measured per foot cube to allow for waste, so that a timber to finish 4 inches by 3 inches must be taken as $4\frac{1}{4}$ inches by $3\frac{1}{4}$ inches; that is, $\frac{1}{8}$ inch extra for each face.

Where one face of a piece of timber must be wrought because it will be exposed, an item per foot superficial must be measured. This is called "labour planing on fir," or "labour wrought face on fir." If the work must be specially good, this labour will be taken on three faces of the timber, as planing one face only leaves rough edges.

138. Timber is measured per foot cube, except where the section is under 9 square inches or 3 inches square. Then it is taken per foot run, unless it is cubed and kept as "in small scantlings." Timbers in short lengths or small quantities must be kept separate, also any timber 25 feet long and over, or 15 inches deep and over.

Where timber work is framed, allowance must be made in the length for tenons. In most cases, tenons pass right through the timber, which is mortised. All floor joists are taken as framed, except those to ground floors, which are termed *ground joists*.

139. To arrive at the number of joists, rafters, etc., required for a given space, it must not always be taken for granted that the number shown on the drawing is correct. Unless otherwise specified, they are 12 inches apart; or, for example, joists 2 inches thick would be 14 inches from centre to centre. The number therefore can be easily found by taking the length of the space and dividing by the distance the joists are placed centre to centre. The result of this will give the number of spaces and not the number of joists, so that one joist must be added for the joist next the wall. A paper scale with the centre line of joists, rafters, etc., marked on will be found useful, but the best plan is to work them out each time from actual dimensions, as many

drawings from which quantities have to be taken are reproductions and not true to scale.

140. Sleeper Plates.—Measure sleeper plates per foot cube. Add to the net length 6 inches for every 20 feet for laps and 12 inches at angles.

141. Ground Joists.—Measure ground joists per foot cube. Collect the several lengths required and shorten where necessary for breasts, etc.

142. Flooring.—Flooring is measured per square of 100 feet superficial. The description should give the thickness, quality, and width of the boards, whether laid folding, straight joint, splayed headings, etc., and also whether ploughed-and-tongued, grooved-and-tongued, rabbeted, etc. Deduct for chimney breasts and voids. Hearths are not usually deducted, as the deduction is set against the glued and mitred borders, the floor being described as "including glued and mitred margins to hearths, hearths not deducted." Of course, if the margins are in hardwood, they must be measured per foot run and the floor deducted. Take per foot run all raking or circular cutting and waste on flooring. Counter flooring under parquet floor is measured per square of 100 feet superficial; the parquet floor is measured per foot superficial, and usually a provisional price per foot laid complete is included for this.

143. Air Bricks.—Describe all air bricks by number, state the size and the material, and include for building in. If in iron and not galvanized, painting must be taken by number.

EXAMPLE.—Take off all the work belonging to the typical, hollow, ground floor shown in Fig. 41, where (*a*) is the plan and (*b*) a cross-section. The surface excavation has already been taken to 12 inches below ground line. The detached $4\frac{1}{2}$-inch sleeper wall *d* is to be built honeycomb in cement, with one course of footings.

SOLUTION.—The first thing to be considered is whether or not the general excavation is sufficient. Fig. 41 (*b*) shows that the depth below the floor to the under side of the rubbish filling is 2 ft. 7 in., which is made up of 1-in. floor, 5-in. joist, 15-in. space, 6-in. concrete, and 4-in. filling. As the floor is 1 ft. 3 in. above the ground line, and the surface has been excavated 1 ft., there remains to be excavated 2 ft. 7 in. — (1 ft. 3 in.

+ 1 ft.) = 4 in. From the plan (*a*), the length of this excavation is 15 ft. less what has been taken with the trenches. This, in the case of the $1\frac{1}{2}$-brick wall, is $11\frac{1}{4}$ in., and for the 1-brick wall is $10\frac{1}{2}$ in. These added together and deducted from the 15 ft. give the length 15 ft. − ($11\frac{1}{4}$ in. + $10\frac{1}{2}$ in.) = 13 ft. $2\frac{1}{4}$ in. The width is given as 10 ft.; this also will be less the $11\frac{1}{4}$ in., as at *e*, and $10\frac{1}{2}$ in., as at *f*, which gives 10 ft. − ($11\frac{1}{4}$ in. + $10\frac{1}{2}$ in.) = 8 ft. $2\frac{1}{4}$ in. A deduction must now be made from this dimension for the breast, which is shown as 4 ft. 9 in.

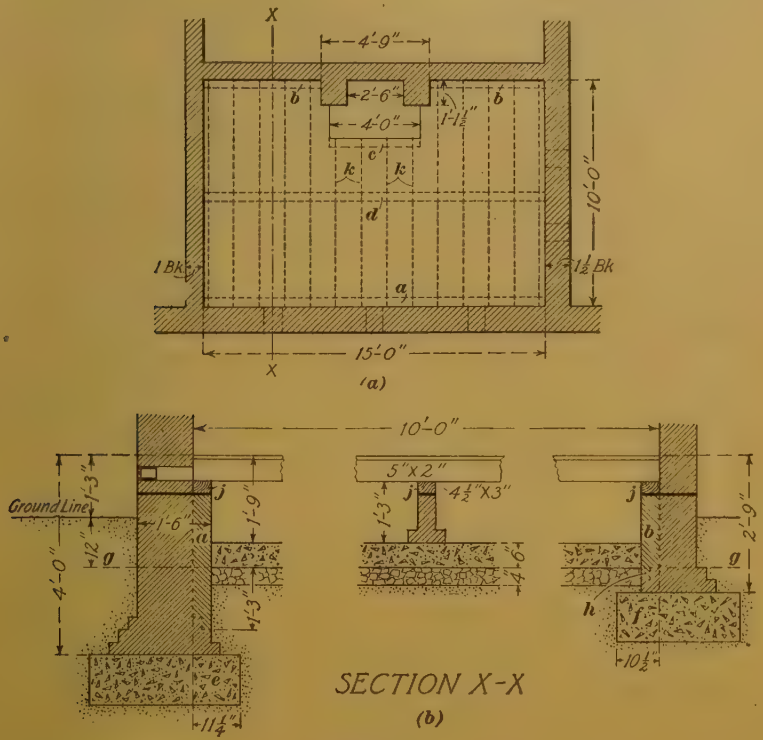

FIG. 41

This will be plus the projection of $10\frac{1}{2}$ in. each side, which would already have been taken. With the excavation for the breast the length of the deduction, therefore, is 4 ft. 9 in. + ($10\frac{1}{2}$ in. × 2) = 6 ft. 6 in. The width is simply the projection of the breast, which in this case is 1 ft. $1\frac{1}{2}$ in.; the depth, of course, is the same as the addition.

The rubbish filling is the full length of 15 ft. by the width of 10 ft. less the thickness of the sleeper walls *a*, *b*, or 10 ft. − ($4\frac{1}{2}$ in. × 2) = 9 ft. 3 in. From this dimension must be deducted the breast, which will be the net length of 4 ft. 9 in. by the projection of 1 ft. $1\frac{1}{2}$ in., less $4\frac{1}{2}$ in. for sleeper

		Floors.
		Ground Floor.
		10 0 / 1 10 / 8 2 — 15 0 / 1 6 / 13 2
13 2 / 8 2 / ·4	35 10	Excavate over surface a b
		4 9 / 1 9 / 6 6
6 6 / 1 2 / ·4	2·6	Ddt last breast
	33·4	
15·0 / 9 3	135 9	Layer of hard dry broken stone or brick 4" thick filled in levelled + well rammed including levelling and ramming ground under.
		+
		Layer of P b Concrete (1 to 6) 6" thick spread + levelled under floors.
4 9 / ·9	3 7	Ddt both breast
	135 2	
		Detached sleeper wall
15 0 / ·3	3 9	1 Bk in mortar + 1 Bk E O in Cement
15 0 / 1 0	15 0	Half brick sleeper wall in cement built honeycomb.

15·0 / ·5	6·3	Horizontal d p. Course a b.
		Sleeper wall next external wall
15·0 / 3·0	45·0	½ Bk in mortar.
		Required 1·6 / Taken 1·2 / 4
15·0 / ·4	5·0	Horizontal d p Course a b.
15·0 / ·4 / 1·3	6·3	Ddt Surface trench r f + r a b. + add Ditto + Cart away a b
		Sleeper wall next internal wall.
		breast 15·0 / 4 9 / 10 3
10·3 / 2·0	20·6	½ Bk in mortar
10·3 / ·5	4 3	Horizontal d. p. Course a b.
		The additional thickness of fender wall to take ends of joists taken with fender walls
3' 15·0 / ·4 / ·3	4 3	Fir in ground joists + sleepers.
		sleepers.

FIG. 42 (a).

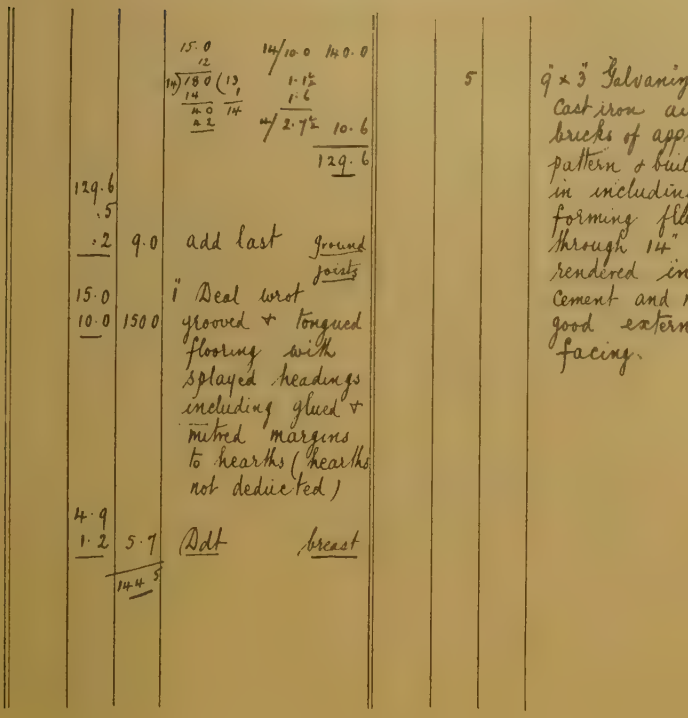

Fig. 42 (*b*)

wall *b*, leaving 9 in. The surface concrete will be exactly the same dimension. The detached sleeper wall *d* is quite simple and needs no further explanation.

The sleeper walls *a* and *b* against the main walls are shown hatched in (*b*), but only to denote the work to be taken. They are built at the same time as the main walls. The sleeper wall *a* against the external wall is the full length of 15 ft.; the height must be taken from (*b*). This shows that there is 4 ft. from the floor level to the bottom of the footings. From this must be deducted 6 in. from floor to top of plate and 6 in. because the sleeper wall stops on top of the second course of footings. The additional damp-proof course will be the same length by the width of 4 in., which width is found by taking the full width required; in this case it is 1 ft. 6 in. minus the 1 ft. 2 in. which is taken with the main wall. The adjustment for the earth carted, instead of returned and filled, is made in the same manner as for brick plinths. The length and width will be the same as for the damp-proof course; the depth is shown in (*b*) as 1 ft. 3 in., which is the depth the sleeper wall goes into the trench. Line *g* shows

the level from which trench excavation would have started, as it is the level to which surface excavation is measured.

The sleeper wall *b* against the internal wall is dealt with in the same manner. The length in this case, however, is minus the breast, which is 4 ft. 9 in. The adjustment for the earth carted is not taken for this wall, for from view (*b*) it will be seen that the portion *h* only amounts to a width of $2\frac{1}{4}$ in. by a height of 3 in.

The wall marked *c* on plan is an additional thickness to the fender wall and would be taken with that wall.

The sleeper plates, or *sleepers*, *j* on top of walls *a*, *b*, and *d* are the full length and can be 3 timesed ; the smaller length on wall *b* is about equal to that required for wall *c*.

The number of ground joists is found by dividing the space to be covered, 15 ft., or 180 in., by the distance from centre to centre of the joists. In this case they are 12 in. apart, and being 2-in. joists they are 14 in. on centres. $180 \div 14 = 13$, nearly. Adding 1 for the joist next the wall makes 14 in all, which agrees with the dotted lines on the plan (*a*). The total length of each joist is 10 ft., but four of them, *k*, are shorter by reason of the breast and hearth. As the breast projects 1 ft. $1\frac{1}{2}$ in. and the hearth 1 ft. 6 in., the total length of ground joists is 10 ft. $\times$ 14 $-$ [(1 ft. $1\frac{1}{2}$ in. $+$ 1 ft. 6 in.) $\times$ 4] $=$ 129 ft. 6 in. The flooring and air bricks need no explanation. The taking off will appear on the dimension paper as in Fig. 42 (*a*) and (*b*).

UPPER FLOORS OF WOOD

144. Plates.—The plates for upper floors of wood are measured per foot cube, the same as sleeper plates. Where the plates are fitted into the side of steel joists or girders they should be measured per foot run, stating that they are "notched and fitted into side of steel joist." Where they are fitted to riveted girders, include for notching over rivet heads. The bolts for fixing should be taken by number. One bolt will be required every 2 to 3 feet. Include the boring through timber with the bolt, but the holes through steel joist must be measured separately. The length of a screw bolt is measured clear of the head. A general rule is, take the thickness of the timber and steel through which the bolt passes plus the thickness of the nut, which is generally the diameter of the bolt ; and, where necessary, plus the thickness of washer, which is usually one-half the diameter of the bolt ; plus $\frac{1}{2}$ inch.

145. Joists.—The joists of upper floors are measured per foot cube and should be described as framed. Collect the different lengths, deducting as necessary for the voids and add for additional joists under partitions, where necessary, and for trimmers and trimming joists, according to what is described in the specification. Generally, each trimmer needs two trimming joists. These trimming joists can generally be measured with the other joists and the additional thickness added. Observe that the ordinary joists are taken sufficiently long to frame into the trimmer and the trimmer to frame into the trimming joists. An allowance of 1 foot 4 inches is usually made for the latter over the net opening to be trimmed. This

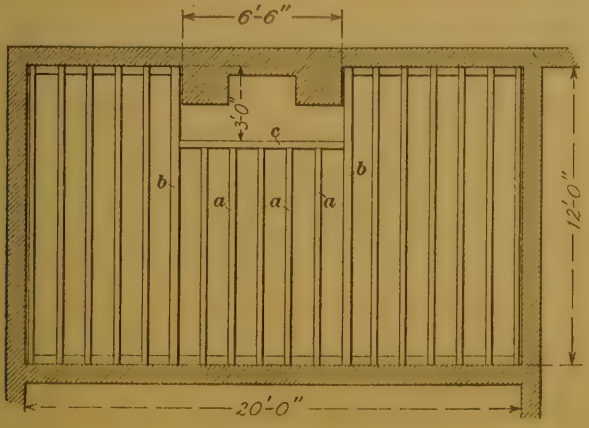

Fig. 43

allows for the tusk tenon and also for cases where the ordinary joists do not come exactly to the edge of the opening trimmed.

Example.—Take off the floor joists and trimmers for the room shown in Fig. 43. The joists are to be 9 inches by 2 inches and the trimmers and trimming joists 1 inch thicker.

Solution.—The number of joists required is found in the manner given in Art. **139.** Five of these *a* are shorter by 3 ft. Joists *b* are trimming joists, which are 1 in. thicker. But only the extra thickness need be added ; this saves making a deduction of 9 in. by 2 in. and adding 9 in. by 3 in. Trimmer *c* is the net length of 6 ft. 6 in. plus the allowance of 1 ft. 4 in. This example appears on the dimension paper as shown in Fig. 44.

146. Herringbone Strutting.—When taking off herringbone strutting, measure per foot run, give the size, and state to what depth of joist. The measurement is found by ignoring the

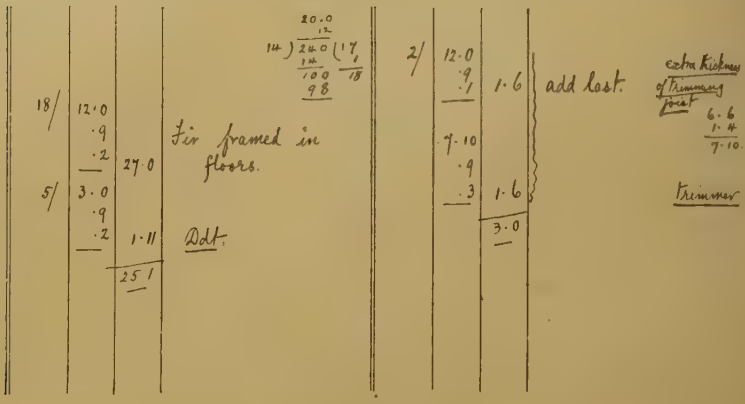

Fig. 44

joists altogether and stating that "the joists are not deducted." If one row of $2'' \times 1\frac{1}{2}''$ herringbone strutting was specified for the floor shown in Fig. 43, the measurement would be as shown in Fig. 45.

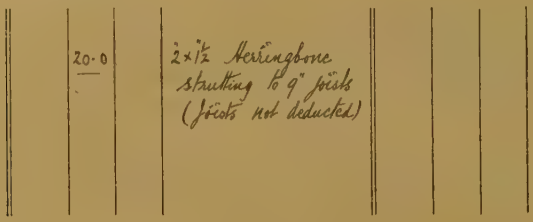

Fig. 45

147. Sound Boarding, Fillets, and Pugging.—Sound boarding, fillets, and pugging are measured per foot superficial over the joists. The description should state that "the joists are not deducted," the thickness of the boarding, and that it includes the fillets; also the material and thickness of the pugging.

148. Tie-Rods.—When taking off tie-rods, measure per foot run and give the size; take the couplings, nuts, and washers

according to number. Afterwards, all should be reduced and billed in hundredweights, quarters, and pounds. Take off by number the boring through fir joists and measure the painting per foot run.

149. Steps Between Floor Levels. All steps between floor levels should be measured as for the ordinary treads and risers of a wooden staircase; but they should be kept separate, as "in small quantities in steps between floor levels."

FIRE-RESISTING UPPER FLOORS

150. Excavation.—The excavations to pier holes for stanchions or columns, concrete foundations, and brick bases are measured all as described for other work of this nature.

151. Base Stones.—All base stones should be numbered and the description should state the kind of stone, the size, and whether rubbed or tooled.

152. Rag Bolts.—Take off rag bolts by number, giving the diameter and length; also include in the description for nut and, if necessary, a washer. Number the holes in the base plate of the column or stanchion and state for what size bolt and through what thickness of metal. When holes are required in cast iron, describe as "holes cast and reamed or drilled through inches of metal for -inch diameter bolts." Mortises for rag bolts should be given by number, stating the depth of mortise and describing the running, whether in cement, lead, or sulphur.

153. Levelling Up Bases.—Levelling up bases of columns or stanchions should be taken off by number and described as "levelling and wedging up between steel (or iron) bases of stanchions (or columns) and stone (or concrete) bases and grouting in cement."

154. Cast-Iron Columns.—Hollow cast-iron columns should be taken off per foot run, but they are given in the bill as in hundredweights, quarters, and pounds. The description should give the number and state to what level they are

hoisted and fixed. To find the amount of metal in the shaft, take the internal diameter plus one thickness of metal, as the diameter. For instance, a 6-inch column of $\frac{1}{2}$-inch metal 10 feet long will be ($6\frac{1}{2}$ inches $\times$ 3·1416) $\times$ 10 feet of $\frac{1}{2}$-inch metal. The constant 3·1416 is generally considered as $3\frac{1}{7}$ when taking off quantities. Caps and bases with the bracketing to same must be added and also the feathers. These latter occur at all internal angles in cast iron and must be allowed for in finding the total weight. There are many methods of making an allowance for feathers; the allowance is only small, so that any of the following methods will be accurate enough. The most common methods are: (*a*) For every 3 feet run, add 1 pound. (*b*) Divide the total length of feathers by 2 for $\frac{1}{2}$-inch square metal. (*c*) Add $2\frac{1}{2}$ per cent. to the total weight. (*d*) Weight out the cast iron at 40 pounds per foot superficial 1 inch thick instead of at $37\frac{1}{2}$ pounds.

All patterns should be taken by number, giving a full description of diameter, length, metal, caps, and bases. Only one pattern is required for any number of columns that are exactly the same, but whenever there is a variation in the design another pattern must be taken or an "alteration to pattern." For instance, if one column is 10 feet long and another is 10 feet 3 inches long, all the other details being the same, only an alteration is required. But if the metal in the shaft is varied, a new pattern must be taken, even though the length is the same.

155. Steel Columns.—Take off steel columns per foot run and afterwards reduce them and bill them in hundredweights, quarters, and pounds. Give the number and fully describe. State to what level they are hoisted and fixed.

156. Steel Stanchions.—Steel stanchions are taken per foot run, and afterwards billed in hundredweights, quarters, and pounds, and should be described as "riveted" and the number given. The description should state of what sections the stanchions consist, and to what level they are to be hoisted and fixed. Add to the weight that of all brackets or tables carrying girders or joists. Allow for all rivets in the weight, by adding from $2\frac{1}{2}$ to 5 per cent., according to the nature of the work, or by

adding so much for each rivet. The latter course, taking an average of $\frac{1}{2}$ pound per rivet, is near enough for ordinary practice. All rivets which are countersunk must be taken by number as "extra for countersinking rivet heads." Wherever the cap or base rests on or has other iron or steel resting on it, an item, by number, of "planing or machining" must be taken, stating the size.

157. Painting.—Painting on iron and steel work or coating with oil or cement wash is measured per yard superficial and the number of coats stated. Separate the work into what is to be executed before and after fixing, and note that the measurement for before fixing will not always be the same as that for after fixing. To find the girth of channels or joists, take the smaller size of the section, multiply by 2, add the larger size, and multiply the whole by 2. For angles and tees, add the two sizes together and multiply by 2. For instance, an $8'' \times 4''$ channel or joist will be [(4 inches $\times$ 2) + 8 inches] $\times$ 2 = 2 feet 8 inches; or a $4'' \times 3''$ angle or **T** will be (4 inches + 3 inches) $\times$ 2 = 1 foot 2 inches.

158. Rolled Joists.—Measure rolled joists per foot run. State the section, weight per foot run, and the height or floor level for hoisting and fixing. Afterwards reduce and bill in hundredweights, quarters, and pounds. Joists of 12 inches by 6 inches section and over should be kept separate in the bill. Allow in the length for ends that go into the walls. The price of steel joists should include cutting to the lengths required. To avoid a claim for cuts, which the steel merchant very often charges, it is advisable to insert in the bill: "In measuring rolled joists, angles, **T**'s, channels, etc., they have been taken the net length and no allowance made for cuts; the prices must include for cutting to the lengths required and for fair ends at meeting joints or abuttals against girders, etc."

159. Riveted Girders.—Riveted girders are measured per foot run for the rolled-joist channel or other sections; but the plates are measured per foot superficial. These dimensions are afterwards reduced and billed in hundredweights, quarters, and pounds. They should be described as "riveted," and the

description should give the number of girders, total length of each, the sections and plates of which the girders are made, and to what level they are hoisted and fixed. An addition should be made to the weight for the riveting, as in the case of stanchions.

160. Ends Cut and Pinned.—When taking off, the ends that are cut and pinned into the walls must be numbered. Joists and girders over 12 inches deep must be kept separate. If any facing is to be made good, the fact must be stated. All ends that go into old walls must be separated.

161. Stone Templates.—Number all stone templates and state the size and thickness. Describe as "tooled," which means that the top or bearing surface is to be tooled. If any edges are exposed, they are generally rubbed, but this fact must be mentioned. All templates must include building in. If they are inserted in an old wall, they must include for "cutting and pinning in cement to old wall and making good."

162. Seatings.—Felt seatings are taken by number. Usually a double thickness of stout boiler felt is specified. Lead seatings are measured per foot superficial, giving the weight per foot, usually 4 pounds. Afterwards the quantity is reduced and billed in hundredweights, quarters, and pounds, and the number stated; for instance, "milled lead in No. 68 seatings under ends of joists, girders, etc., cut to sizes required."

163. Connections.—Ends of steel joists, etc., that must be notched and fitted into other joists are numbered. State specially where the ends are joggled. **Joggling** is where the flange is bent up instead of being cut off. Fish-plates, angle and other cleats, bolts, and holes are taken off by number. Separate each and fully describe the sizes. Distance pieces are taken by number and must be fully described by number.

164. Casing Joists or Girders Below Soffit of Floor.—Joists and girders which show below the soffit of floor are usually encased with concrete. They should be measured per foot run, stating the size. This casing may be described as follows: "Extra over breeze (or other) concrete floor for casing down in similar concrete round steel joists or girders to form beam

inches wide on soffit and inches below floor level, including additional centring and casing (the flat boarded centring is not deducted)."

165. Concrete Floors.—Concrete floors are measured per yard superficial. The description should give the thickness, composition of the concrete, and at what floor level it is to be laid. It should also state that it is "filled in between and round steel joists on centring (measured separately)." In the measurement, where the floor is not supported on offsets in the wall, allow both in the length and in the width for going into the walls; the depth in the wall will vary and should be according to specification. It is either $1\frac{1}{2}$, $2\frac{1}{4}$, or $4\frac{1}{2}$ inches, generally the latter, which it will be safe to include for if nothing to the contrary is specified. Consequently, for a floor 20 feet by 10 feet with a $2\frac{1}{4}$-inch chase in wall all round, the dimension will be 20 feet $4\frac{1}{2}$ inches by 10 feet $4\frac{1}{2}$ inches, which will be entered as 20 feet 5 inches by 10 feet 5 inches.

166. Chases in Wall.—Chases in wall for concrete floors are measured per foot run, the depth of chase and for what thickness floor should be given.

167. Flat-Boarded Centring.—Measure per square of 100 feet superficial all flat-boarded centring. State that it includes "strutting up or suspending, easing, striking, and removing." Sides which are on rake must have an item taken per foot run of "raking, cutting, and waste on centring."

168. Temporary Boarding to Edges of Concrete.—All openings in concrete floors need flat boarding vertically to support the concrete; this boarding should be measured per foot run as "temporary boarding and support to edge of concrete floor inches thick."

QUANTITIES AND ESTIMATING

(PART 2)

TAKING OFF

(*Continued*)

MODE OF MEASUREMENT AND EXAMPLES

QUARTER PARTITIONS

1. The heads and sills, interties, wall posts, angle posts, braces and quarters of quarter partitions, and posts to openings should be measured per foot cube. They should be described as "fir framed in partitions." If trussed, the fact must be stated. Allow in the lengths of heads, sills, and interties for the portion in wall; usually each end goes in about 6 inches. Take the angle posts of sufficient scantling to correspond with the thickness of the partition; partitions constructed of $4\frac{1}{2}'' \times 2''$ studs require $4\frac{1}{2}'' \times 4\frac{1}{2}''$ angle posts.

2. Bridging Pieces.—Where the sill of partition runs parallel with the floor joists and double joists are not specified under partitions, bridging pieces or bearers must be taken one about every 2 feet. Give the scantling and length and describe as "framed both ends between floor joists."

3. Bolts and Straps.—Measure all bolts and straps per foot run, giving the sizes and fully describing. Afterwards reduce and bill in hundredweights, quarters, and pounds.

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BRICK-NOGGED PARTITIONS

4. The timbers for brick-nogged partitions should be measured the same as quarter partitions. The nogging pieces should be measured per foot run, giving the scantling. Do not deduct for other timbers, but describe as "measured over all." Measure the brick nogging per yard superficial. State the thickness, whether it is to be laid in mortar or cement, and that the price is to include all cutting. All openings must be deducted, but not the timbers. At the end of the description, state that "all timbers are measured separately and are not deducted from this measurement."

CONCRETE PARTITIONS

5. Concrete partitions are usually made of breeze concrete and are measured per yard superficial. The description should give the thickness and composition and should include temporary boarding and shuttering to both sides. If the partitions are chased into the wall at the ends, the length will be increased by the depth of this chase. All openings are deducted and an item taken for the temporary boarding to edges; but as these are dealt with in taking the openings, not when measuring the partitions, the description should state that "all openings are deducted." Chases in walls are measured per foot run. Describe the depth of chase and for what thickness of partition.

6. **Rods.**—Steel or iron rods used as stiffeners to partitions should be measured per foot run. The description should state the size; the rods should afterwards be reduced and billed in hundredweights, quarters, and pounds. In the length, allow for ends which are forged for fixing at top or bottom to joists, etc.; also, take by number the ends so forged and fully describe the fixing.

PATENT PARTITIONS

7. There are very many patent partitions on the market, but usually they can be measured per yard superficial. The manufacturer's name, the thickness, and the method of setting

should be given. If the partition is chased into the wall, allow in the measurement and take an item similar to that given for concrete partitions. If the fixing is by means of wooden fillets fixed to the wall, measure these fillets per foot run, state the size, and describe as "plugged."

LEAD FLATS

8. Plates and Joists.—The plates and joists for lead flats should be measured in the manner given for the upper floors of wood.

9. Boarding.—The boarding for lead flats is measured per square of 100 feet superficial. In the description, state the thickness and describe as "edges shot and traversed for lead." The furrings on top of the joists to form the fall are sometimes measured separately, but usually they are included with the boarding, which is then described as "on and including furrings to falls."

10. Felt.—Felt is not always specified under flats, but when specified, it is taken off the same as for roof slopes. Measure per yard superficial, stating if a special make is to be used and giving any special trade mark. Describe as "well lapped and nailed, measured net, no allowance made for laps."

11. Drips and Rolls. — Measure per foot run all drips and rolls, giving the size. The height of a drip denotes its size; for instance, $1\frac{1}{2}$-inch or 2-inch cross-rabbeted drip. Rolls are known by their diameters, such as $1\frac{1}{2}$-inch or 2-inch rounded roll for lead. Include, with the roll, the splayed ends, but take according to number all mitred intersections.

12. Leadwork.—When taking off leadwork, measure per foot superficial, giving the weight per foot. Afterwards reduce and bill in hundredweights, quarters, and pounds. To the length and width measured on the flat, the following additions should be made: Under slates or tiles, 9 inches; against brick or stone, 6 inches; over edge into gutter, 3 inches; $1\frac{1}{2}$-inch drips, 6 inches; 2-inch drips, 8 inches; $1\frac{1}{2}$-inch rolls, 6 inches; 2-inch rolls,

8 inches. Drips should never be more than 10 feet apart, and rolls should be from 2 feet to 2 feet 3 inches apart, or not exceeding 2 feet 6 inches from centre to centre.

13. Bossed Ends and Intersections.—Bossed ends to rolls and intersections of rolls should be taken by number. Bossed ends against the wall are not usually measured; if they are, they must be kept separate from the ordinary bossed ends.

14. Flashings.—Flashings are measured per foot superficial, the weight per foot being given. Afterwards the quantity is reduced and billed in hundredweights, quarters, and pounds. The cover flashings to lead flats are usually taken 6 inches wide. Where necessary, the following allowances must be added to the length: At all angles, whether internal or external, 6 inches; that is, 3 inches on each piece of lead. At all passings, 4 inches every 10 feet. Tacks vary considerably, but one every 3 feet in length will be about right. They should be about 7 or 8 inches long and 2 inches wide and of the same weight lead as to flashings, unless otherwise directed.

15. Raking Out Joints and Wedging and Pointing Flashings. When taking off the item of raking out joints and wedging and pointing flashings, measure per foot run. State whether the wedges are to be of lead or hardwood; stepped flashings must be kept separate. The length will be the same as for the flashings. Ignore all allowances for angles, passings, etc. This item should be described as "rake out joints of brickwork, wedge with lead or hardwood wedges, and point in cement to lead flashings."

16. Eaves.—The eaves fascia should be measured per foot run and the description should state the thickness and height. It should also state whether the fascia is square, chamfered, beaded, or moulded, and whether plugged to brickwork. Take by number all mitres, and splayed, fitted, or fair ends. The painting is measured per foot run and is described as " oils on eaves fascia."

17. Eaves gutters are measured per foot run. The item should state the size and weight, if from a particular manufacturer, and if jointed in red lead and bolted; it should also

state whether the gutters are to be screwed through back to the fascia or rafter feet, bedded on brickwork and blocked up to falls, or supported on brackets. The brackets can be included with the gutter, but they must be fully described. All gutters circular on plan must be kept separate and the radius stated, as generally they must be specially made.

Eaves gutters are measured net as fixed ; that is, no allowance is made for the gutter where hidden in the socket. As there is sometimes some misunderstanding as to how the measurements are made, the following note in the bill is advisable : " The eaves gutters and rain-water pipes have been measured the net lengths as fixed, and the prices are to include for all short or special lengths and also for all requisite patterns."

Take by number all internal, external, and irregular angles, stopped ends, returned and mitred ends, and outlets, and describe outlets as " with short sockets cast on." Take to each outlet a copper or galvanized-iron wire domical grating. The painting on eaves gutters is measured per foot run. The number of coats must be given and described as " inside and out." They are usually painted before and after fixing.

18. Rain-Water Heads. — Measure all rain-water heads by number and state how fixed. If anything more than plain moulded heads is required, quote a number from a manufacturer's catalogue or include a provisional sum. Take for each head a copper or galvanized-iron wire flat or domical grating. If flat gratings are specified and the heads receive other pipes, these gratings must be described as " perforated as required for waste pipes." The painting on rain-water heads is taken by number.

19. Rain-Water Pipes.—When taking off rain-water pipes, state the size and weight, and measure per foot run. If jointed in red lead or with caulked joints inside the building, or if from a particular manufacturer, the fact must be stated. The description must also state if ears are cast on, what nails are to be used, and whether the pipes are fastened to plugs driven into the wall. It should also state if ornamental bands, holderbats, distance pieces, etc., are used. If the pipes are fixed to glazed-brick

facing or other work, except the ordinary brick facing, the item must be kept separate. Pipes are measured net as fixed.

Measure by number all bends, swannecks, junctions, plinth bends, shoes, etc. State the projection for swannecks and plinth bends and describe for what sizes of pipe the junctions are required. These items are usually measured as "extra for," which means extra over the price of ordinary pipes. When this is done, their lengths must be measured and included in the length of the pipe. Connections to drains, and chases or perforations in stone and brick strings, etc., are taken off by number and a full description is given. Painting to them is measured per foot run.

ZINC FLATS

20. Flats covered with zinc in lieu of lead are measured in exactly the same way as described for the latter material. They have the same allowances with the following exceptions: As the sheets are shorter, the drips are more frequent. The zinc is kept in feet superficial, and the gauge is given. The price for zinc usually includes all labour except the soldered shields or patent caps to the ends of rolls; these shields or caps are taken by number. The rounded rolls taken for lead flats are replaced by twice-splayed fillets; these are measured per foot run and the size is given.

CONCRETE FLATS

21. Concrete flats and work in connection therewith should be measured in exactly the same way as fire-resisting upper floors. Concrete flats should be described as "finished on top to falls" and the levels should be given; for instance, "at flat level over second floor." The floated bed for asphalt should be described as "laid to falls."

22. Asphalt Covering.—The asphalt covering of concrete flats should be measured per yard superficial and described as "laid to falls." The description should state the kind and thickness of the covering, also if laid in two thicknesses, and if it is to be laid by the workmen of a particular company. The levels should be given in the same manner as for concrete flats.

23. Vulcanite and Other Covering.—Such patent coverings as vulcanite and ruberoid can generally be measured per yard superficial. Information as to the best method of measuring can always be obtained from the manufacturers or their agents.

24. Asphalt Skirtings.—Measure asphalt skirtings per foot run. State the height and thickness and include for the angle fillet at the bottom and the turning in or other method of finishing the top edge. Also include for the groove in brick or stone and the pointing in cement. Take by number all angles and fair ends. By *fair end* is meant one that is exposed, necessitating extra labour in finishing.

Skirtings are superseded by lead flashings for some of the patent roof coverings; these flashings should be measured as described in Art. **14.** If the asphalt covering of a flat finishes and drips direct into an iron eaves gutter, measure an extra labour per foot run; a lead apron should also be specified under the edge of the asphalt flat, and should be measured as directed for lead flashings.

25. Channels or Gutters in Flats.—Channels or gutters formed in the concrete flats are measured per foot run. State the size and that they are to falls. Include the extra cement floating with the description. A typical description is "extra labour and moulds forming half-round channel in breeze concrete flat 6 inches wide to falls, including floating with cement and sand to receive the asphalt." The angles and stopped ends are taken by number. When these channels or gutters are lined with asphalt, the lining should be measured as extra over the asphalt flat and the items of angles and stopped ends taken by number. This lining may be described as follows: "Extra labour and material lining half-round channel 6 inches wide to falls with $\frac{3}{4}$-inch asphalt in two thicknesses."

26. Outlets.—The outlets through walls for the discharge of water from the flats into rain-water heads are measured by number. The hole through the wall is kept separate, and its size and the thickness of wall are given and described as fair, because the finishing to the hole is in facing work and not rough

work. State what facing there is on both sides of the wall and the kind of lintel or arch over the opening. The asphalt lining of the opening must be fully described, including the skirting, angle fillets, etc. Also, it is well to include any necessary lead apron or splashing piece into the rain-water head.

27. **Cesspools.**—Cesspools in concrete flats are measured per number and described as "extra labour and moulds forming cesspools in concrete flats." State the size and include for cement floating for the asphalt. The asphalt lining should be taken by number, stating the size and including all angle fillets. Domical gratings should be taken for all cesspools in the same manner as for rain-water heads.

28. **Socket Pipes.**—Give by number the size, weight, length or girth, of socket pipes and state the number of times they must be bent. Also give the method of fixing at one or both ends. Perforations through walls for socket pipes should be taken by number, the diameter of pipe and the thickness of wall being given and described as "raking." Also state what facing, etc., must be made good.

TIMBER ROOF TRUSSES

29. **Timbers.**—The tie-beams, principal rafters, kingposts or queenposts, struts, collars, etc., of roof trusses are measured per foot cube and described as "fir framed in roof trusses, including hoisting and fixing." If the whole of the truss is finally to be exposed, the timber should be described as "wrought," which is usually abbreviated to "wrot" on the dimension paper. In measuring the timbers, allowance must be made for framing the timbers through each other.

30. **Painting, or Staining and Varnishing.**—Painting, or staining and varnishing on roof trusses must be kept separate from general work and described as "on roof boarding and timbers." Timbers and boarding which are to be stained and varnished must be described as "selected and kept clean for staining and varnishing."

31. Straps and Bolts.—All straps and bolts that are 12 inches long and over are measured per foot run, and afterwards reduced and billed in hundredweights, quarters, and pounds. Bolts less than 12 inches long are measured by number. The straps and bolts must be described as "including fixing by carpenter." The description for straps should be "wrought iron in forged roof straps holed for bolts and fixing by carpenter." The boring for bolts which are numbered should be included with the bolt; but the boring for bolts which are weighted must be taken separately, either per foot run or by number.

The painting on roof straps and bolts 12 inches long and over is measured per foot run, and on bolts under 12 inches long is measured by number. The painting on straps that must be finally exposed is usually black, as a contrast against the painting on woodwork. When this is so, describe as "on straps cut in all edges."

TABLE I

WEIGHTS OF HEADS, NUTS, AND WASHERS

Diameter of Bolt Inch	Weight of Head and Nut Pounds	Weight of Washers Pounds
$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{6}$
$\frac{5}{8}$	$\frac{1}{3}$	$\frac{1}{3}$
$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{2}$
$\frac{7}{8}$	$\frac{3}{4}$	$\frac{4}{5}$
1	$1\frac{1}{4}$	$1\frac{1}{4}$

In measuring bolts which are to be given in the bill by weight, allowance must be made for the heads, nuts, and any washers. Several tables have been prepared for the weights of these, but the approximate weights given in Table I will be found near enough for most ordinary work.

32. Heads and Shoes to Roof Trusses.—Cast-iron heads and shoes to roof trusses are best measured by number. Give the approximate weight and include the pattern holes and fixing. If there is more than one of each from the same pattern, the pattern should be measured as a separate item. Take off the painting by number.

33. Purlin Cleats.—Purlin cleats should be taken by number. The description should give the size and state if wrought.

STEEL OR IRON ROOF TRUSSES

34. Steel or iron roof trusses, together with the connecting plates, cleats for purlins, and jaws for ridges, etc., which are riveted on to the truss, are measured in detail and reduced so as to bill in hundredweights, quarters, and pounds. The members are best measured per foot run, giving the section, and the connecting plates, etc., per foot superficial, stating the thickness. For these latter, measure the extreme and deduct the wants for splays, etc. The rivets should be dealt with as described for steel stanchions. The trusses must be fully described, the clear span stated, and the height given from pavement or ground level to springing and to apex of truss for hoisting and fixing. A description like the following will give the general idea: "Steel in No. 5 framed roof trusses 34 feet clear span, consisting of coupled **T** principal rafters and uprights, coupled flat-bar ties, coupled angle struts, etc., connecting plates, cleats for purlins, and jaws for ridge, including all cutting, fitting, bending, forging, rivets and riveting, bolts and bolting, and all drilling complete, and hoisting and fixing over first floor 25 feet from pavement level to springing line and 38 feet to apex of truss." If the shoes rest on top of stanchions, an item of "planing or machining" must be taken.

35. Painting.—Painting on trusses is best kept separate from painting on other iron and steel work. Note that the difference in the girth of members may be very marked between that before erection or fixing and that after fixing. Painting on connecting plates is measured per foot superficial and described as "on connecting plates of roof trusses." The members are best taken per foot run and the description should state that they do not exceed 6, 9, 12 inches, etc., in girth. It should be described as "on members of roof trusses not exceeding inches girth."

36. Shoes Cut and Pinned.—Take by number the shoes which are built in or cut and pinned to brickwork. Templates, seatings, and rag bolts are taken as already described. If the holes in the shoes are to be slotted, this fact must be stated.

PURLINS

37. Timber.—Purlins are measured per foot cube and described as "fir framed in roofs." Allow about 6 inches in the length for ends in wall, while for halved joints over roof principals or other bearers allow from 6 to 12 inches. Scarfed joints occur every 15 to 20 feet, except where over principals. From 3 to 4 times the depth of the purlin should be added to the length of the purlin for these scarfs. Take the bolts as before directed and also an item according to number for "extra to scarfed joints in ″ × ″ purlins including keys and wedges. Extra timber and bolts are measured separately."

38. Edges.—Labour to chamfered or moulded edges is taken per foot run. If stopped, the fact must be stated and the description made to include for the stops.

39. Coach Screws.—Take coach screws by number, giving the size and length. Include in the description for "driving in fir" or other wood.

RIDGES

40. Timber.—Ridges 2 inches thick and under are measured per foot superficial; over 2 inches thick they are measured per foot cube. Allow about 6 inches in the length for ends in wall. Scarfs should be taken every 15 feet, but bolts should be taken only if specified.

41. Edges.—The top edges of ridges are usually chamfered. This is taken twice the length of the ridge per foot run as "labour rough chamfer on fir." The bottom edges should be taken in the same manner as the edges of purlins.

42. Corbels.—Rough stone or other corbels are usually specified where timbers are next flues. These should be measured by number, including the building in.

43. Tile or Slate Ridges.—Measure tile or slate ridges per foot run. Describe fully and state method of fixing and that it is to suit pitch of roof. Take according to number all fair ends, fitted ends, intersections, and finials.

44. Ridge Rolls.—Take ridge rolls per foot run, giving the size. They are usually birdsmouthed on to ridges and hips, and therefore should be kept separate from ordinary rounded rolls for lead. Include for the splayed ends, but take by number all mitred intersections.

45. Lead.—The lead covering to ridges is measured per foot superficial, giving the weight per foot. This quantity is afterwards reduced and billed in hundredweights, quarters, and pounds. The width is usually taken as 18 inches; this allows about 6 inches down on slates or tiles both sides. If more is needed the width must be increased. To the net length must be added the allowance for passings, about 4 inches every 7 feet, and for each end against wall or at intersections 6 inches. Tacks must be taken as for the flashings of lead flats. These, of course, must be taken for both sides of the ridge. Bossed ends and intersections should be measured as directed in Art. **13**. The intersections are described as of "ridge and two hip rolls."

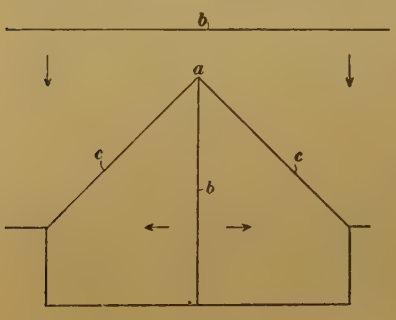


FIG. 1

46. Soakers for Abutting Ridges.—A lead soaker 18 inches square should be taken where lead-covered ridges cut into or stop against a roof slope, as at *a*, Fig. 1, or abut against the sides of a chimney stack or other tile or slate ridges. In Fig. 1, *b*, *b* are the ridges and *c*, *c* the valleys.

HIPS

47. Length of Hips.—The length of a hip may be found by taking the length of the hip on plan and setting up at either end a perpendicular line equal to the total rise of the slope. By joining the two open ends, the length of the side opposite the right angle will be the length of the hip. Thus, to find the length on slope of hip *a b*, Fig. 2, erect at *b* a perpendicular

line *b c* equal to the total rise of the slope ; the length of the line *a c* will be the length of the hip.

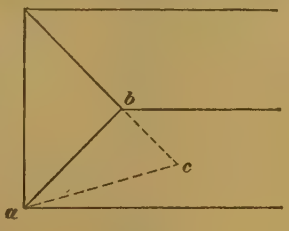


FIG. 2

48. Timber and Edges.—Hips 2 inches thick and under should be measured per foot superficial; when over 2 inches thick, hips should be measured per foot cube. The labour on edges of hips should be measured the same as on the edges of ridges.

49. Slate and Tile Hips.—Measure slate hips as described for ridges. Measure tile hips per foot run and describe as "extra to hip tiles to suit pitches of roof, including cutting and waste and bonding on both sides." Take by number any iron hip hooks, scrolls, etc.

50. Cut and Mitred Hips and Soakers.—Where hips are cut and mitred an item must be taken, per foot run, of "extra to close cut and mitred hips, including cutting and waste on both sides." State if hips are to be pointed. A continuous piece of lead or soakers are required under cut and mitred hips.

51. Hip Rolls.—Hip rolls and lead coverings should be measured the same as ridges.

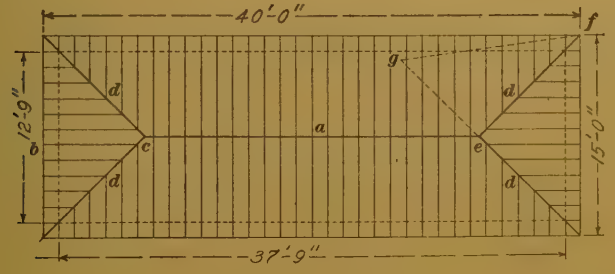


FIG. 3

EXAMPLE.—Take off the ridges and hips to the roof shown in Fig. 3, the ridges and hips being 10" × 2" fir covered with tiles. Ridge terminals, prime cost 10s. each, are to be provided at intersection of ridge and hips, and wrought-iron scroll hip hooks at bottom of hips. These are to be given two coats of oil paint before and two coats after fixing.

The rise of the roof is 8 feet 5 inches, and the length of the hipped ends, as at *b c*, is 7 feet 6 inches.

SOLUTION.—The length of the ridge *a* is found by deducting from the total length, 40 ft., twice the length *b c* of the hipped ends on plan, or 40 ft. — (7 ft. 6 in. × 2) = 25 ft. Making an allowance of 3 times the

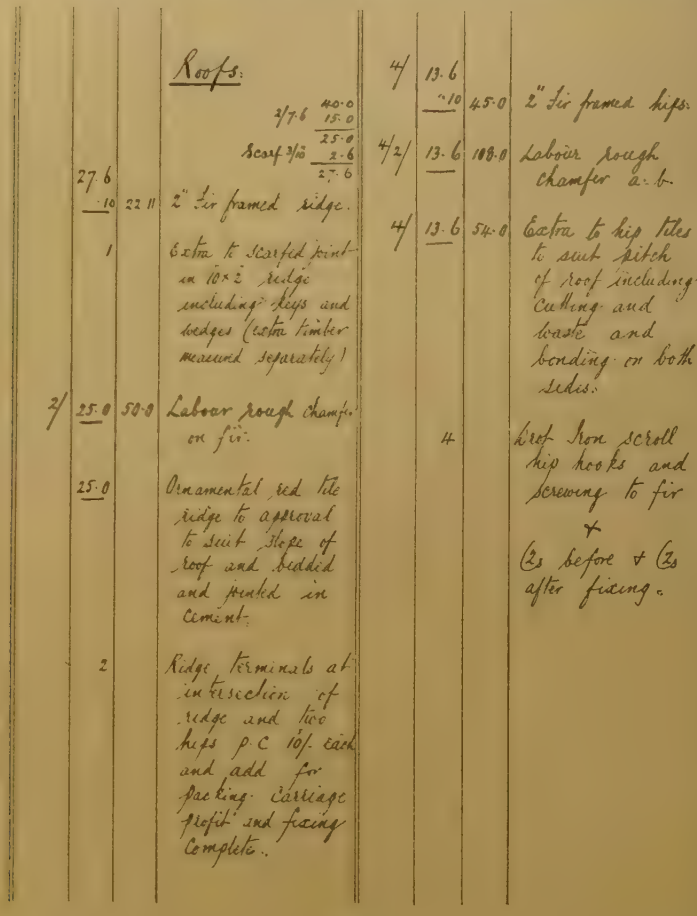

Roofs.
2/7.6 40.0 15.0 25.0
Scarf 3/10 2.6 27.6
27.6 10 22 11 2" Fir framed ridge.
1 Extra to scarfed joint in 10×2 ridge including keys and wedges (extra timber measured separately)
2/ 25.0 50.0 Labour rough chamf. on fir.
25.0 Ornamental red tile ridge to approval to suit slope of roof and bedded and pointed in cement.
2 Ridge terminals at intersection of ridge and two hips p.c 10/- each and add for packing carriage profit and fixing complete.
4/ 13.6 10 45.0 2" Fir framed hips.
4/2/ 13.6 108.0 Labour rough chamfer a.b.
4/ 13.6 54.0 Extra to hip tiles to suit pitch of roof including cutting and waste and bonding on both sides.
4 Bref Iron scroll hip hooks and screwing to fir
(2s before + (2s after fixing.

FIG. 4

depth for one scarfed joint, the total length of the ridge is 25 ft. + (10 in. × 3) = 27 ft. 6 in. The other lengths for the ridge will be net, the allowance for scarf being ignored.

To find the length of the four hips *d*, erect at *e*, perpendicular to the hip *c f*, a line *e g* equal to the total rise of the roof, or 8 ft. 5 in.; then the line *g f* gives the length of hip, or 13 ft. 6 in. The method of taking

off is shown in Fig. 4. The last item in Fig. 4 is 2 oils before and 2 oils after fixing, meaning that the hooks are to be painted two coats of oil or other colour before and two coats of oil or other colour after fixing.

VALLEYS

52. The length of valleys should be found and the timber and edges measured in the same manner as the hips.

53. Tile Valleys.—Tile valleys should be measured per foot run and described as "extra to valley tiles to suit pitches of roof, including cutting and waste and bonding on both sides."

54. Valley Boarding.—Lead valleys that occur in a roof where the slate or tile battens are fixed to the rafters without the use of roof boarding must have a layer board placed on the slope at each side of the valley rafter to take the lead. Measure this board per foot superficial, stating thickness and including the splayed edges. Where the valleys are to have *soles*, or boarding supported on bearers fixed between the rafters, measure the soles per foot run when 6 inches wide and under, and per foot superficial when over 6 inches wide. Include in the description for the splayed edges and bearers.

55. Tilting Fillets.—Tilting fillets should be measured per foot run and described as "feather-edged tilting fillets." This fillet is required for both sides of the valley.

56. When taking the lead work of valleys, measure per foot superficial, giving the weight per foot, and afterwards reduce and bill in hundredweights, quarters, and pounds. The width is usually taken as from 20 to 22 inches, but if the valley has a sole the width must be increased by whatever the width of the sole is. To the net length must be added the allowance for passings, or about 4 inches every 7 feet and 6 inches at each end.

ROOF TIMBERS

57. Wall Plates and Dragon Pieces.—The wall plates for roof timbers should be measured per foot cube and allowances made as directed for other plates. Dragon pieces and angle ties at

hipped ends are measured per foot cube and added to the item "fir framed in roofs."

58. Rafters.—When taking off rafters measure per foot cube, as generally directed for carpenter's work. The number required is found in exactly the same way as for the floor joists, but it is not always necessary to add a joist to the result of the calculation. In the case of a roof hipped at both ends, if the external length of the roof has been taken one rafter will have to be deducted, because the hips take the place of two rafters.

A roof, however hipped, has the same area as a gabled roof, provided the slopes are the same; therefore, in taking rafters to a roof with hipped ends, the rafters may be collected for the whole length, disregarding the hipped ends; usually 1 foot is added to the length of the rafters for every two rafters that abut against the hip, as an allowance for the waste on the jack rafters.

59. Cut Ends of Rafters.—Take by number the cut ends of rafters. State the length for which they are wrought, and the scantling of the rafter. If they are shaped, give a sketch.

60. Sprockets.—Take the sprockets by number, give the scantling and the total length. State if wrought, cut, and shaped, and how fixed.

61. Collars.—Collars are measured per foot cube in the manner directed for rafters. They should be added to the item "fir framed in roofs."

62. Ceiling Joists and Plates.—The plates for ceiling joists should be measured in the same manner as other plates. Ceiling joists should be measured the same as rafters and floor joists. The rule given for small scantlings for carpenter's work will probably apply here.

EXAMPLE.—Take off the plates and rafters for the roof shown in Fig. 3. The plates are $4\frac{1}{2}$ inches by 3 inches and the rafters 6 inches by 2 inches spaced 14 inches centre to centre.

SOLUTION.—A roof of this description requires a plate on all four walls. As the plate is on the inside thickness of the wall, the length must be the internal round of the walls plus 12 in. for each angle and a lap of 6 in. for each long side; or,

(37 ft. 9 in. + 12 ft. 9 in.) × 2 + (12 in. × 4) + (6 in. × 2) = 106 ft.

The length of rafters may be taken as 11 ft. 3 in. The number required on each side is the outside length divided by the distance between centres, or $\frac{40 \text{ ft.}}{14 \text{ in.}} = 34$. As one rafter on each side must be deducted for the hip rafter, the length of rafters is 11 ft. 3 in. $\times$ 33 $\times$ 2 = 742 ft. 6 in.

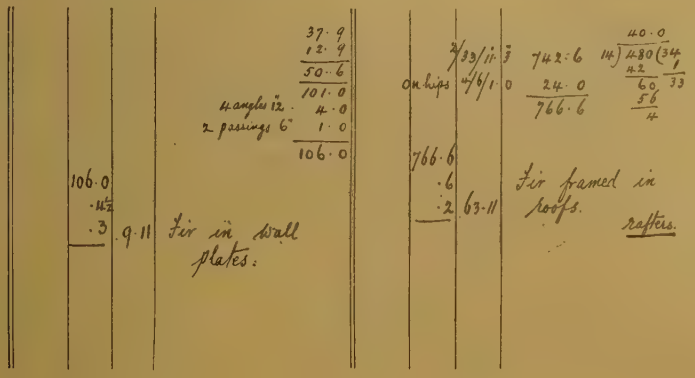


Fig. 5

As there are six rafters on each side of each hip, an allowance of 1 ft. $\times$ 6 $\times$ 4 = 24 ft. must be made; this gives the total length of rafters required as 742 ft. 6 in. + 24 ft. = 766 ft. 6 in. The taking off is entered on the dimension paper as shown in Fig. 5.

ROOF COVERINGS

63. Areas.—The areas of roofs for the coverings are found by taking the length on plan multiplied by the measurement on the slope taken from the sections. The fact that a roof, however hipped, has the same area as one without hips, provided the slopes are the same, must be specially kept in mind in taking coverings, as it will save much time and needless dimensions. An error that sometimes occurs through forgetfulness, and one that must be specially guarded against, is omitting to double the roof slopes where a roof is ridged in the centre.

64. Boarding.—Measure roof boarding per square of 100 feet superficial. The description should state the thickness, whether or not the edges are shot, whether wrought on one or both sides, grooved and tongued, V-jointed, etc. The boarding to circular

roofs must be kept separate and described as in narrow widths; very often it must be laid in two thicknesses.

65. Felt.—Felt is measured per yard superficial, as described for lead flats.

66. Battens.—Slating and tiling battens are measured per square of 100 feet superficial. The width and thickness should be given, and the description should state whether for tiles or slates and to what gauge. Vertical or ventilating battens are measured per square of 100 feet superficial. The description should give the width and thickness and should state the distance from centre to centre. Very often tiling battens are included with the item of tiling.

67. Cuttings.—An allowance must be made for cutting and waste on boarding, felt, and battens to all hips, valleys, and other rakes. This is the length of the hips, valleys, or other rakes supered by 3 inches in each case and the result added to the respective items. As this is for each raking edge, for hips and valleys this allowance must be made for each side.

68. Splayed Edges on Boarding.—Take off the splayed edges on boarding per foot run. State the thickness of the boarding and whether *across grain* or not. The term **across grain** is used for all labours that must be worked across the grain of the wood. Splayed edges occur at ridges, hips, and valleys, and very often at eaves, according to the detail.

69. Gauge or Lap.—The gauge of slating or tiling is found by taking the length of the slate or tile, deducting the lap, and dividing the remainder by 2. Or the lap may be found by deducting twice the gauge from the length of the slate or tile.

70. Slating.—When taking off slating, measure per square of 100 feet superficial. Describe the kind of slate, state if from any particular quarry, and give the trade name, with size. The gauge or lap, the kind of nails, the number to each slate, and the weight per 1,000 should be given. Circular slating should be separated and the radius given.

71. Tiling.—Plain tiling is measured per square of 100 feet superficial. The kind of tile should be described, and if from any particular maker, the fact should be stated; also whether nibbed or not. The gauge or lap and the kind of nails or pins should be given. The description of nibbed tiling should state whether any courses are to be fixed, and if so, state how often. Circular tiling should be kept separate and the radius given. Pan tiling is measured per square of 100 feet superficial. The gauge should be given and whether pointed inside or out, or both.

72. Cutting and Waste on Slating.—As there are differences of opinion as to what allowances should be made in the measurement of slating for items that entail cutting and waste, these items should be taken per foot run. Then, the estimator can see exactly how the work is measured and can make his price accordingly. Nothing is gained by supering up items and adding in with the general slating; this practice leaves the estimator in doubt as to what has been measured, which is exactly what the taker off should particularly avoid.

At ridges, take the length on both sides as "cutting and waste to top edges of slating." At abutments, take the length as "cutting and waste to square abutments"; this will only be measured at one end where a roof is between two parapets. Where on rake or skew on plan, describe as "raking, cutting, and waste to skew abutments." Circular cuttings should be described as "circular cutting and waste." At valleys, take the length on both sides as "cutting and waste to sides of valleys, both sides being measured." At hips, take the length on both sides as "cutting and waste to hips, both sides being measured." Of course, this item would not be measured in the case of cut and mitred hips, but the description would be as previously given for cut and mitred hips.

73. Cutting and Waste on Tiling.—Cutting and waste on tiling should be measured per foot run. At ridges, take the length on both sides as "cutting and waste to top edges of tiling." At abutments, take the length as "cutting and waste to square abutments." This should be measured at only one end, where a roof is between two parapets. Where on rake or

skew on plan, describe as "raking, cutting, and waste to skew abutments." Circular cuttings should be taken as "circular cutting and waste." At valleys, take the length on both sides as "cutting and waste to sides of valleys, both sides being measured." This item should not be measured in the case of valley tiles being used, as the cutting and waste would be included with the tiles.

At hips, take the length on both sides and describe as "cutting and waste to hips, both sides being measured." This item is not measured if hip tiles are used, nor in the case of cut and mitred hips, as in both cases the cutting and waste are included with the descriptions previously given for hips.

74. Verges.—Verges are measured per foot run and described as "extra to verges." The description should state if pointed in cement and if slates of slate and a half width, or tiles of tile and a half width, are to be used, and if an extra under or cloak course is to be fixed. If the verges are on skew or rake, there must be added to the description "on skew, including cutting and waste."

75. Eaves Tilting Fillets.—Measure the tilting fillets at eaves per foot run and state the size out of which they are to be cut; for instance, "eaves tilting fillet out of $5'' \times 2''$."

76. Eaves Course.—Measure the eaves course to slating or tiling per foot run and describe as "extra to eaves course." When on rake or when cut to suit the fall of gutters, the description should be "extra to eaves course to falls, including cutting and waste."

77. Standard System.—The following is the standard system of measurement of slating and roof tiling as agreed on by the Council of the Quantity Surveyors' Association and the London Association of Slate Merchants and Master Slaters. This also agrees in the main with the customary rules of measurement codified by the principal master slaters and tilers in the London and South of England districts for 1909, except that in the latter some items are supered by a certain allowance and added to the superficial area instead of being given per foot run.

SLATING

Superficial.—A superficial measurement of the slating to be given representing the net area covered after deducting all openings containing 4 superficial feet and over. The slating to sides of mansard roofs and vertical slating to dormer cheeks, gables, etc., to be similarly measured but given separately. Circular slating to be similarly measured and given separately with radius of slating and any other special description. The description of slating to conical, octagonal, or other turrets to state the diameter at the base and apex and the height of roof. The description in all cases to state the kind and size of the slates, length of lap, method of fixing, and the kind and number of nails to each slate, and if to include for torching or bedding.

Eaves.—A linear measurement of all eaves to be given as "extra to eaves course," and to state, when required, to be bedded in cement. When the eaves are raking or cut to suit the fall of gutters, the above description to be supplemented by the words "to falls including cutting and waste."

Verges.—A linear measurement to be given as "extra to verges," and to state, when required: (1) whether slates of slate and half width are intended to be used; (2) whether an extra under or cloak course is to be fixed; and (3) if the item is to include for pointing to the edge in cement.

NOTE.—When the verges are on skew, the above description to be supplemented by the words "on a skew including cutting and waste."

Top Edge of Slating.—A linear measurement of all top edges of the slating to be given as "cutting and waste to top edge of slating," and this is also to be given under sills of dormers, lanterns, skylights, and against lower sides of chimney stacks, and all other openings which occur in the slating.

Square Abutments.—A linear measurement of all cuttings of slating to be given as "cutting and waste to square abutments," and to be given where the slating abuts against the sides of all chimney stacks, dormer cheeks, skylights, and other openings. Where the slating is executed between two parapet walls, similar cutting is to be measured at one end of the roof only.

Cuttings.—A linear measurement of all cuttings against skew abutments to be given as "raking, cutting, and waste to skew abutments." A linear measurement of all circular cuttings to be given as "circular cutting and waste."

Valleys.—A linear measurement on both sides of all valleys to be given as "cutting and waste to sides of valleys, both sides measured."

Hips.—A linear measurement on both sides of all hips where coverings are used to be given as "cutting and waste to hips, both sides measured." A linear measurement of all mitred hips to be given as "extra to close

cut and mitred hips and including cutting and waste on both sides." If pointed, to be so described.

Ridges.—A linear measurement of tile or slate ridges and hips with description to be given, and all cut and splayed ends separately given. All mitres and intersections to be numbered and fully described.

ROOF TILING

Superficial Measurement of Tiling. — A superficial measurement of the tiling to be given representing the net area covered after deducting all openings containing 4 superficial feet and over. The tiling to sides of mansard roofs and vertical tiling to dormer cheeks, gables, etc., to be similarly measured but given separately. Circular tiling to be similarly measured and given separately with radius of tiling and any other special description. The description of tiling to conical, octagonal, or other turrets to state the diameter at the base and apex and the height of roof. The description in all cases to state the kind and size of the tiles, the lap to which they are to be laid, the method of fixing, the kind and number of nails or pegs to each tile, and if to include for torching, or bedding.

Eaves.—A linear measurement of all eaves to be given as " extra to eaves course," and to state, when required, to be bedded in cement. When the eaves are raking, or cut to suit the fall of gutters, the above description to be supplemented by the words " to falls including cutting and waste."

Verges.—A linear measurement of all verges to be given as " extra to verges," and to state, when required: (1) whether tiles of tile and half width are intended to be used; (2) whether an extra under or cloak course is to be fixed; and (3) if the item is to include for pointing to edge in cement.

NOTE.—When the verges are on skew, the above description to be supplemented by the words " on a skew including cutting and waste."

Top Edge of Tiling.—A linear measurement of all top edges of tiling to be given as " cutting and waste to top edges of tiling," and this is also to be given under sills of dormers, lanterns, skylights, and against lower sides of chimney stacks, and all other openings which occur in the tiling.

Square Abutments —A linear measurement of all cuttings of tiling to be given as " cutting and waste to square abutments," and to be given where the tiling abuts against the sides of all chimney stacks, dormer cheeks, skylights, and other openings. Where the tiling is executed between two parapet walls, similar cutting is to be measured at one end of roof only.

Cuttings.—A linear measurement of all cuttings against skew abutments to be given as " raking, cutting, and waste on tiling to skew abutments." A linear measurement of all circular cuttings to be given as " circular cutting and waste."

Valleys.—A linear measurement on both sides of all open valleys to be given as " cutting and waste to sides of valleys, both sides measured."

If bedded and pointed, to be so stated. Where valley tiles are used, a linear measurement to be given as " extra to valley tiles to suit pitches of roof, including cutting and waste and bonding on both sides."

Hips and Angle Tiles.—A linear measurement on both sides of all hips where coverings are to be used to be given as " cutting and waste to hips, both sides measured." A linear measurement of all mitred hips to be given as " extra to cut and mitred hips, and including cutting and waste on both sides," and, if pointed, to be so described. Where, in the place of coverings, hip tiles, or angle tiles for vertical tiling, are used, a linear measurement to be given as " extra to hip tiles to suit pitches of roof, or angle tiles for vertical tiling, including cutting and waste and bonding on both sides."

Ridge Tiles.—A linear measurement of ridges with description to be given, and all cut or splayed ends separately given. All mitres, intersections, specially made tiles, and finials to be numbered and fully described.

78. Barge Boards.—Barge boards should be measured per foot run, giving the size and fully describing all the labours on same. Take also per foot run any mouldings, giving the size and stating if scribed to soffit of roof tiling, etc. Take by number the mitres to barge boards and mouldings, also the ends if these latter are increased in size. Give the full description and, if necessary, a sketch of what is required.

79. Half-Timber Work.—Half-timber work is measured per foot run. Give the scantling of each member and fully describe all labours on same. All the members should be described as framed. If pinned, state with what kind of pins and whether left projecting or not. Half-timber work is best kept separate under a heading. Brackets to overhanging barge boards, etc., should be taken by number, stating the scantlings and fully describing. A sketch will often be found useful.

EXAMPLE.—Take off the covering of the roof shown in Fig. 6, which consists of $\frac{3}{4}$-inch boarding with edges shot, inodorous roofing felt, $1\frac{3}{4}'' \times \frac{3}{4}''$ sawn battens, and plain red Broseley roof tiling laid to a 4-inch gauge and each tile nailed with and including two $1\frac{1}{2}$-inch copper nails weighing 5 pounds per 1,000. Assume that the ridges and hips, which have already been taken, are of tiles and the valleys of lead. The length on the slope from the ridge to the eaves is 11 feet 3 inches and the length of the hips and valleys is 13 feet 6 inches.

SOLUTION.—First find the area of the roof, as this is also the area of the boarding, felt, battens, and tiling. Ignoring the hipped ends c, d and the roof slopes e, f cutting into slope b, the area of the slopes a, b is

40 ft. × 11 ft. 3 in. × 2 = 900 ft. super. The area of the slopes *g*, *h* is 15 ft. × 11 ft. 3 in. × 2 = 337 ft. 6 in. super. The total roof area, therefore, is 900 ft. + 337 ft. 6 in. = 1,237 ft. 6 in. super.

The allowance for cutting and waste on roof boarding, felt, and battens is the length of the hips *j* and the valleys *k* supered by 3 in. on each side. The length of each hip and valley is 13 ft. 6 in.; therefore the dimension will be 13 ft. 6 in. × 3 in. × 2 × (4 + 2) = 40 ft. 6 in. super.

Along the eaves *l*, the splayed edge on the boarding is 40 ft. long. Along the eaves *m*, *n* it is 40 ft. — 15 ft. = 25 ft. Each of the eaves *o*, *p*, *r*, *s* is 15 ft. long. Therefore the total splayed edge along the eaves is 40 ft. + 25 ft. + (15 ft. × 4) = 125 ft. Along the ridge *t* of the main roof the splayed edge is the length minus the hipped ends *c*, *d*, each of which is 7 ft. 6 in., or 40 ft. — (7 ft. 6 in. × 2) = 25 ft. The length of

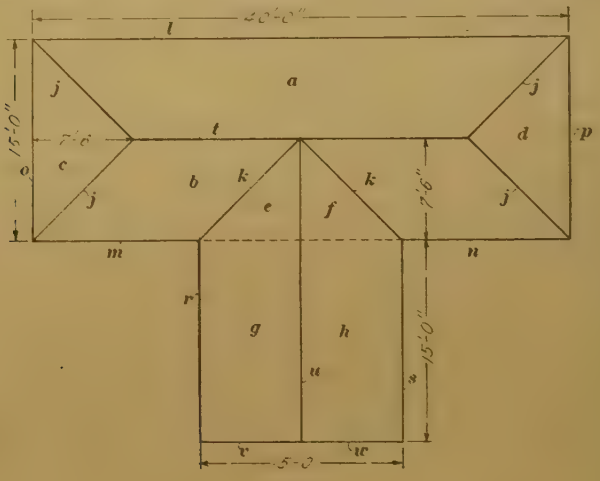


Fig. 6

the ridge *u* is 15 ft. plus the length between the slopes *e*, *f*, or 15 ft. + 7 ft. 6 in. — 22 ft. 6 in. The total length of splayed edges on the ridges thus obtained must be multiplied by 2, as the edge is on each side of the ridge; therefore (25 ft. + 22 ft. 6 in.) × 2 = 95 ft. The edges to the hips and valleys will be separate, as they are across the grain, but the length is exactly the same as for the item of cutting and waste on boarding, etc.

For the cutting and waste on tiling, the ridges will be exactly the same length as for splayed edges at these places. The valleys are of lead, so cutting and waste must be taken to the two valleys *k*, each 13 ft. 6 in. long, multiplied by 2 to obtain both sides. No cutting and waste must be taken for hips at this stage, as they are of tiles, and the cutting and waste will be included with the hip tiles.

The length of the two verges *v*, *w* is the same as the roof slopes, or 11 ft. 3 in. The length of the eaves tilting fillet and eaves course in tiling

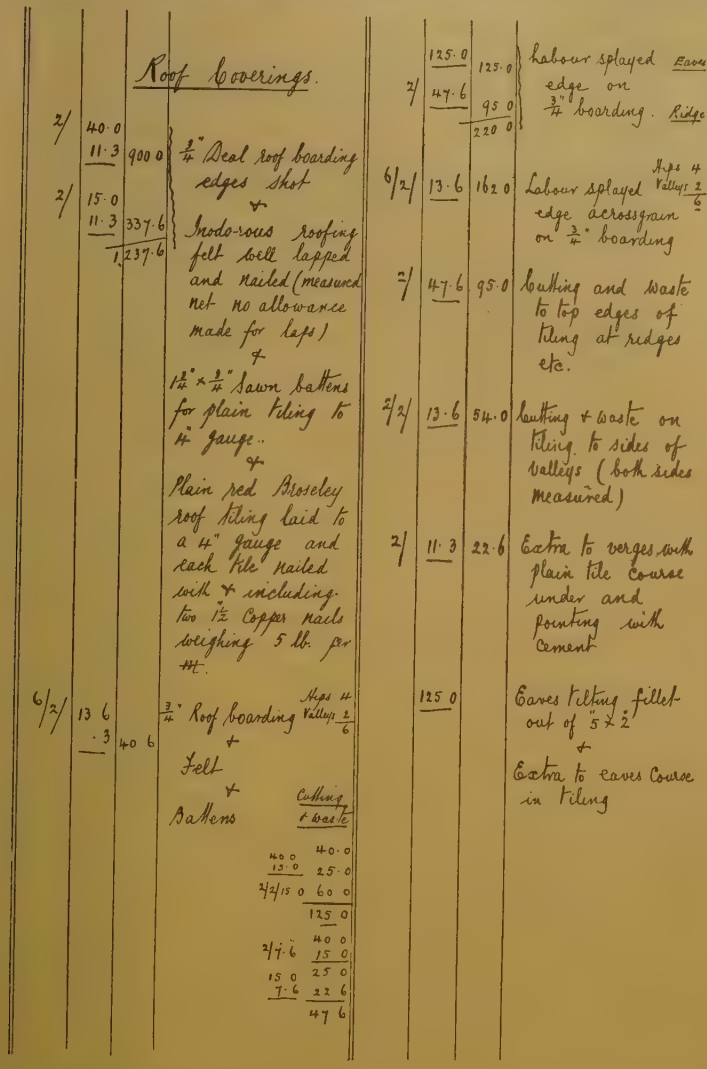

Roof Coverings.
2/ 40·0 / 11·3 900 0 — ¼" Deal roof boarding edges shot + Ivodorous roofing felt well lapped and nailed (measured net no allowance made for laps) + 1½" × ¾" Sawn battens for plain tiling to 4" gauge. + Plain red Broseley roof tiling laid to a 4" gauge and each tile nailed with + including two 1½ Copper nails weighing 5 lb. per M.
2/ 15·0 / 11·3 337·6 / 1,237·6
6/2/ 13 6 / ·3 40 6 — ¾" Roof boarding Hips 4 Valleys 2/6 + Felt + Battens
Cutting & waste
40·0 / 15·0 25·0 / 2/2/15 0 60 0 / 125 0
40 0 / 2/7·6 15 0 / 15 0 25 0 / 7·6 22 6 / 47 6
125·0 / 2/ 47·6 125·0 95 0 / 220 0 — Labour splayed Eave edge on ¾" boarding. Ridge
6/2/ 13·6 162 0 — Labour splayed Hips 4 Valleys 2/6 edge across grain on ¾" boarding
2/ 47·6 95·0 — Cutting and waste to top edges of tiling at ridges etc.
2/2/ 13·6 54·0 — Cutting & waste on tiling to sides of valleys (both sides measured)
2/ 11·3 22·6 — Extra to verges with plain tile Course under and pointing with cement
125 0 — Eaves tilting fillet out of 5 × 2 + Extra to eaves Course in tiling

FIG. 7

is the same as the splayed edge at the eaves. All the foregoing dimensions are entered as in Fig. 7. It will be seen that the description of copper nails is given as 5 lb. per M, which signifies 5 lb. per thousand.

FLASHINGS TO RAKES

80. Position.—Flashings, etc., to rakes occur in such positions as where a roof slope abuts against a brick wall or other vertical face ; for instance, a gable end of roof with brick parapets above the roof slope, sides of chimney stacks, and similar positions.

81. Soakers.—Soakers should be measured per foot superficial. When they are of lead, give the weight per foot and afterwards reduce and bill in hundredweights, quarters, and pounds ; where of zinc, the gauge must be given. In addition to the weight, the number of soakers which the weight represents must be given, as the price includes fixing by the slater or tiler. The description should be " milled lead in No. soakers cut

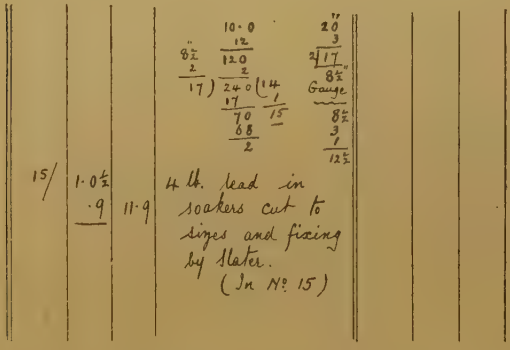


Fig. 8

to sizes and fixing by slater or tiler." Sometimes the fixing of soakers is taken separately by number and billed with the slater or tiler ; the description of this item should be " fixing only lead soakers."

To find the length of a soaker, add to the gauge of the slate or tile the lap and 1 inch. The width of the soaker should be specified, generally either 8 or 9 inches, half being under the slates or tiles and half against the vertical face.

To find the number of soakers required for a given slope, divide the length on the slope by the gauge of the slates or tiles. For instance, if a slope 10 feet long is covered with countess slates laid to a 3-inch lap, the length of slate being 20 inches,

the gauge will be (20 inches − 3 inches) ÷ 2 = $8\frac{1}{2}$ inches. The length of each soaker will be $8\frac{1}{2}$ inches + 3 inches + 1 inch = $12\frac{1}{2}$ inches; its width may, in this case, be taken as 9 inches. The number of soakers required will therefore be 10 feet ÷ $8\frac{1}{2}$ inches = $14\frac{2}{17}$, which would be called 15 and the dimension entered as in Fig. 8.

82. Table II gives the size, lap, gauge, length of soaker, and the number of soakers required in a 10-foot slope for the slates and tiles most generally used.

TABLE II

LEAD SOAKERS

Name of Slate or Tile	Size Inches	Lap Inches	Gauge Inches	Length of Soaker Inches	Number Required in 10-Foot Slope
Countess slates .	20 × 10	$2\frac{1}{2}$	$8\frac{3}{4}$	$12\frac{1}{4}$	13·71
Countess slates .	20 × 10	3	$8\frac{1}{2}$	$12\frac{1}{2}$	14·12
Duchess slates .	24 × 12	$2\frac{1}{2}$	$10\frac{3}{4}$	$14\frac{1}{4}$	11·16
Duchess slates .	24 × 12	3	$10\frac{1}{2}$	$14\frac{1}{2}$	11·43
Viscountess slates	18 × 10	$2\frac{1}{2}$	$7\frac{3}{4}$	$11\frac{1}{4}$	15·48
Viscountess slates	18 × 10	3	$7\frac{1}{2}$	$11\frac{1}{2}$	16·00
Ladies slates . .	16 × 8	$2\frac{1}{2}$	$6\frac{3}{4}$	$10\frac{1}{4}$	17·77
Ladies slates . .	16 × 8	3	$6\frac{1}{2}$	$10\frac{1}{2}$	18·46
Ladies slates . .	14 × 12	$2\frac{1}{2}$	$5\frac{3}{4}$	$9\frac{1}{4}$	20·87
Ladies slates . .	14 × 12	3	$5\frac{1}{2}$	$9\frac{1}{2}$	21·82
Plain tiles . . .	$10\frac{1}{2}$ × $6\frac{1}{2}$	$4\frac{1}{2}$	3	$8\frac{1}{2}$	40·00
Plain tiles . . .	$10\frac{1}{2}$ × $6\frac{1}{2}$	4	$3\frac{1}{4}$	$8\frac{1}{4}$	36·92
Plain tiles . . .	$10\frac{1}{2}$ × $6\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	8	34·29
Plain tiles . . .	$10\frac{1}{2}$ × $6\frac{1}{2}$	3	$3\frac{3}{4}$	$7\frac{3}{4}$	32·00
Plain tiles . . .	$10\frac{1}{2}$ × $6\frac{1}{2}$	$2\frac{1}{2}$	4	$7\frac{1}{2}$	30·00

83. Stepped Flashings.—The stepped flashings which cover the turn up of the lead soakers against the wall should be measured in the same manner as the other flashings and the same allowances must be made. It must be remembered that stepped flashings occur only against brickwork; in the case of a roof

slope abutting against stonework, the top edge of the flashing should be let into a raking groove instead of being stepped into the joints as in brickwork. The stepped flashings should be taken from 6 to 8 inches wide. Raking out the joints and wedging and pointing should be measured as described for other lead flashings.

84. Secret Gutters.—Sometimes in lieu of soakers secret gutters are specified; for these a tilting fillet must be taken down the rake, the same as for valleys. The leadwork should be measured as for flashings and the same allowances taken where they apply. The width of lead varies according to the width of the gutter; as opinions differ very considerably as to the width of gutter, the specification should be quite clear as to what width is required. It should state the width of the sole, how much is turned up against the vertical side, and what is the allowance over the tilting fillet and up the roof slope, or else the total width can be given. The secret gutters require a stepped flashing, as for soakers.

CHIMNEY STACKS THROUGH ROOFS

85. Deductions.—When chimney stacks pass through roofs, the rafters must be deducted and the trimming joists and trimmers added; this is done in exactly the same manner as the deductions for floors. The area of boarding, felt, battens, and slating or tiling displaced by any stack must be deducted where it exceeds 4 feet superficial. An allowance must then be added for cutting and waste on boarding, felt, and battens, arrived at by taking the length round the edges of the opening supered by 3 inches. To obtain the allowance for cutting and waste on slating or tiling, measure the top edge as an eaves course to falls, the bottom edge as the top edges of ridges, and the two sides as square abutments.

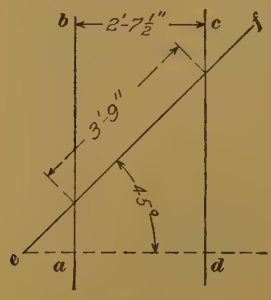


FIG. 9

Since the dimensions given for a chimney are those of the plan, the length of the roof slope that is to be deducted must be found. This may be done by setting out two vertical lines *a b*, *c d*, Fig. 9, the same distance apart as the sides of the stack, then drawing through these a line *e f* that has the same angle with the horizontal as the slope of the roof. The length of the line *e f* between the vertical lines *a b*, *c d* is the length of the roof slope cut by the stack. For instance, if the distance *a d* is 2 feet $7\frac{1}{2}$ inches and the angle of the roof slope is 45°, the roof slope is nearly 3 feet 9 inches.

86. Gutter Boards.—The eaves to the gutter behind the top of the chimney require a tilting fillet; but this is generally smaller than the main eaves tilting fillet, so that it is taken as the same kind as to valleys. Gutter boards are usually measured per foot run for chimney gutters. The thickness and width should be stated and the bearers included. The ends of the gutter require *gusset ends*, which should be taken by number. **Gusset ends** are the spandrel filling-in pieces between the top of rafter and the under side of gutter board. If the gutter is to fall both ways, a roll must be taken by number, described as "short 2-inch rounded roll for lead."

87. Lead for Chimney Gutters.—Lead for chimney gutters should be measured per foot superficial, giving the weight per foot. The length of the lead should be the width of the stack plus the allowance for roll, if necessary, plus 18 inches. This last is an allowance of 9 inches at each end for dressing down over the gusset ends. The width of the lead should be the average width of the gutter sole plus 6 inches for the turn up against the stack and plus 9 inches for going up under slates or tiles. The cover flashings should be measured in the same manner as flashings for lead flats.

88. Flashings and Aprons.—To the slope of roof next the two sides of stack, soakers and stepped flashings or secret gutters and stepped flashings must be taken. To the front or lower face of the stack, a lead apron should be taken; this is usually about 12 inches wide. To the length of each piece of lead for

flashings and aprons add 6 inches, that is, 3 inches at each end, so that at the angles there will be an allowance of 6 inches made up of the 3 inches on each piece.

EXAMPLE.—Take off all the work in connection with the six-flue stack in the tiled roof shown in Fig. 10. The roof has a slope of 45°, the length of slope is 11 feet 3 inches, the rafters are 6 inches by 2 inches, and the trimmers and trimming joists 1 inch thicker. The gutter is to be of 6-pound lead, the flashings and apron of 5-pound lead, and the soakers of 4-pound lead. The tiles are laid to a 4-inch gauge, with battens, felt, and $\frac{3}{4}$-inch roof boarding under. The gutter is to have a $1\frac{1}{4}$-inch gutter board and 2-inch rounded roll.

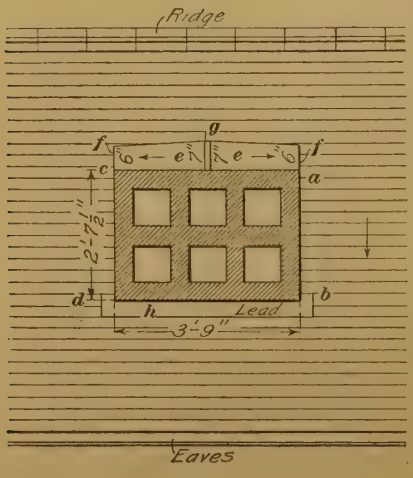


FIG. 10

SOLUTION.—The first dimension that is wanted and is not given is the length of the edges *a b* and *c d* of the roof slope adjoining the side of the stack. As these sides are 2 ft. $7\frac{1}{2}$ in. long on plan, and the roof slopes at an angle of 45°, the length of the slope will be nearly 3 ft. 9 in., which length can be used for all measurements to the sides of the stack adjoining the roof slope, and is the length of rafters that must be deducted. To find the number of rafters cut into by the stack, divide the side *b d* by the distance between the centres of the rafters; or 3 ft. 9 in. ÷ 14 in. = 3 and a fraction over.

The length on the slope from ridge to eaves is given as 11 ft. 3 in.; so this will be the length for two trimming joists, one on either side of stack, but only the extra thickness of these, or 1 in., must be taken. The two trimmers at *a c*, *b d* must now be added, 3 ft. 9 in. plus an allowance of 1 ft. 4 in. being the length.

The covering that must be deducted is the area *a b d c*, or 3 ft. 9 in. × 3 ft. 9 in. = 14 ft. 1 in. super. The slope measurement is a little more than 3 ft. 9 in. on account of the gutter *e e*, but no notice should be taken of this. The allowance of 3 in. for cutting and waste on boarding, felt, and battens will be to the four sides, each of which in this case is 3 ft. 9 in. long. The allowance for cutting and waste on tiling will be 3 ft. 9 in. of eaves course to the gutter *e e*, 3 ft. 9 in. of top edge at *d b*, and 3 ft. 9 in. × 2 of square abutment to edges *a b* and *c d*. The tilting fillet and the gutter boards to the gutter *e e* are 3 ft. 9 in. in length. The

gusset ends are at *f*, *f*, and the roll dividing the gutter so as to fall both ways is shown at *g*. The gutter lead is the length plus the allowance for the gussets plus the roll *g*; or 3 ft. 9 in. + 18 in. + 8 in. = 5 ft. 11 in. The width is the average width on the sole, or $\frac{6 \text{ in.} + 7 \text{ in.}}{2} = 6\frac{1}{2}$ in. To this must be added 9 in. for going under the tiles and 6 in. for turning up against the stack; or $6\frac{1}{2}$ in. + 9 in. + 6 in. = 1 ft. $9\frac{1}{2}$ in. The length of the cover flashing is the 3 ft. 9 in. from *a* to *c* plus the allowance of 3 in. at each end, or 3 ft. 9 in. + (3 in. × 2) = 4 ft. 3 in.

The soakers to the sides *a b* and *c d* will be $7\frac{1}{2}$ in. long, which is found by taking the gauge of 4 in. plus the lap of $2\frac{1}{2}$ in. plus 1 in. supered by the usual width of 9 in. The number of soakers required to each side will be the length on the slope divided by the gauge; or 3 ft. 9 in. ÷ 4 in. = 11 and a fraction over, which would be taken as 12. The stepped flashing to the soakers must be the length of 3 ft. 9 in. plus the allowance of 3 in. at each end supered by 8 in. The apron *h* will be the length of 3 ft. 9 in. plus the allowance of 3 in. at each end supered by 12 in. The dimensions are entered on the dimension paper as shown in Fig. 11 (*a*) and (*b*).

LEAD GUTTERS

89. Setting Out.—Before starting to take off any lead gutter, whether it is to a valley or next a parapet, figure up in pencil on the plan and set out the position of the drips in the length and calculate the width on the sole. This is most important, as it is not possible to scale them accurately from the drawings, and lead is one of the most costly materials used in building. First settle the position of the drips, which should not be more than 10 feet apart, unless specially wanted; if drawn more than 10 feet apart, inquire whether the additional length is really intended. For the width on the sole, it is necessary to know: (*a*) the fall of the gutter, which is usually $1\frac{1}{2}$ inches in 10 feet; (*b*) the depth of the drips, from $1\frac{1}{2}$ or $2\frac{1}{2}$ inches; (*c*) the width at the narrowest part, usually not less than 9 inches; (*d*) the pitch of the roof. To be able to figure the width on the plan, set out a section of the whole gutter to a large scale, so that it may be scaled from, as shown in Fig. 12 (*a*), where *a* is the roof slope, *b* the width of gutter at the narrowest part, *c* the rise of gutter in its length between drips, *d* the depth of the drips, and *e* the roll dividing the fall of the gutter. Another method is to find the increase of width of the gutter for every

inch of rise by drawing a section to a large scale, as in (*b*), and then calculating from this the increase of width at each drip, etc.

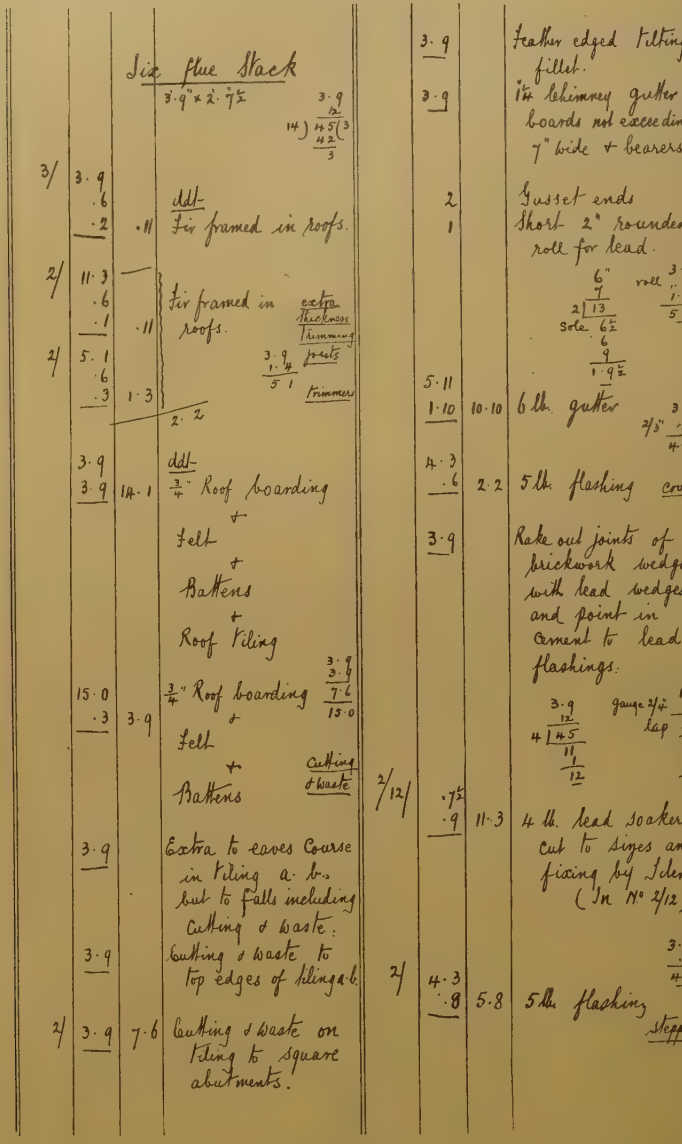

Six flue Stack
3·9" × 2·7½
3·9
12
14) 45(3
42
3
3/ 3·9 ·6 ·2 ·11 ddt Fir framed in roofs.
2/ 11·3 ·6 ·1 ·11 Fir framed in roofs. extra thickness Trimming joists
2/ 5·1 ·6 ·3 1·3 trimmers
3·9 1·4 5 1
2·2
3·9 ddt
3·9 14·1 ¾" Roof boarding + Felt + Battens + Roof tiling
3·9 3·9 7·6 15·0
15·0 ·3 3·9 ¾" Roof boarding + Felt + Battens Cutting & waste
3·9 Extra to eaves Course in tiling a. b. but to falls including Cutting & waste.
3·9 Cutting & waste to top edges of tilings a.b.
2/ 3·9 7·6 Cutting & waste on tiling to square abutments.
3·9 Feather edged tilting fillet.
3·9 1½ lehinney gutter boards not exceeding 7" wide & bearers.
2 Gusset ends
1 Short 2" rounded roll for lead.
6" roll 3·9 ·8 1·6 5 11
2 13 Sole 6½ 6 9 1·9½
5·11
1·10 10·10 6 lb. gutter 3·9 2/3" ·2 4·3
4·3 ·6 2·2 5 lb. flashing cover
3·9 Rake out joints of brickwork wedge with lead wedges and point in cement to lead flashings.
3·9 gauge 2½ 10½ 12 lap 2½ 4 2½ 1 7½
4 45 11 1 12
2/12/ ·7½ ·9 11·3 4 lb. lead soakers cut to sizes and fixing by Tiler (In N° 2/12)
3·9 ⅙ 4·3
2/ 4·3 ·8 5·8 5 lb. flashing stepped

FIG. 11 (*a*)

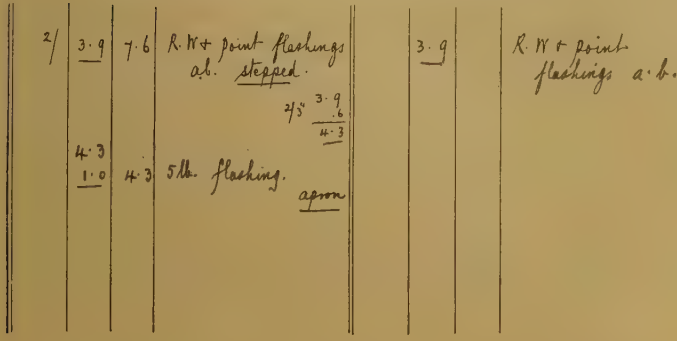


Fig. 11 (*b*)

The latter view, where *a*, *a* are the roof slopes, shows that for every inch in rise in this case the increase in width is $3\frac{1}{4}$ inches. The second method is the one most usually adopted.

90. Averaging.—When the drips are a uniform distance apart, long lengths of gutter may be taken together by averaging the width on the sole ; but when the drips are at unequal distances, considerable error will result from this method.

Fig. 12

91. Gutter Boards and Bearers.—Measure gutter boards and bearers per foot superficial, giving the thickness and stating if the bearers are framed. Include in the description an item for splayed edges. The width will be the average of the sole. If gutters are to have felt, this should be measured as described for lead flats.

92. Drips and Rolls.—The drips and rolls to lead gutters are measured as for lead flats ; but where 2 feet long or under, they are taken by number and described as " short."

93. Gusset Ends and Cesspools.—Take gusset ends and deal cesspools by number. For cesspools, state the thickness, size, and depth in clear and describe as "dovetailed."

94. Lead to Gutters.—The leadwork to gutters should be measured the same as for lead flats, and the same allowances should be made, except in the case of the 9 inches under slates or tiles. If this allowance is considered sufficient, it should be specified. For a steep pitch, an allowance of 9 inches represents a very good vertical height up the roof; but for a flat sweep, many will consider that it is not sufficient. Very often it is specified that the lead must be carried up the roof slope equal to a vertical height of 6 inches. In this case, the allowance may be found by drawing through two parallel horizontal lines *a b*, *c d*, Fig. 13, 6 inches apart, a line *e f* with the same angle to the horizontal as the slope of the roof. The length of the intercepted line *e f* will be the allowance required; but to this 1 inch must be added for the extra over the tilting fillet.

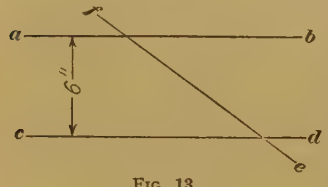


FIG. 13

Additional lead must be taken for any cesspools. Measure the gutter over the cesspools; the lead so measured will do for the bottom of the cesspool. Then take the girth round the sides plus 1 inch supered by the height plus 3 inches. Where the cesspools are to be bossed out of one piece of lead, deduct the lead taken with the gutter less 2 inches each way and add the piece of lead necessary for the cesspool.

95. Snow Boards or Gratings.—Measure all snow boards or gratings per foot superficial. Fully describe the size of fillets, stating the distance apart; also give the size of bearers, with their distance apart, and state if screwed together and if they are to be tarred. Snow boards for gutters should always be described as "in lengths to suit drips of gutters and in varying widths, as required to suit gutters." In practically all cases the measurement should be the same as for gutter boards and bearers.

96. Sundries.—The labour to cesspools should be taken by number and described as "extra labour and solder to cesspools," or, where soldering is not allowed, "extra labour bossing -pound lead to cesspools." Gratings in cesspools should be taken by number and described as for rain-water heads. Socket pipes and perforations should be taken by number the same as for concrete flats.

EXAMPLE.—Take off all the work for the lead gutter shown in Fig. 14. The gutter runs alongside a parapet and the roof adjoining has a slope of 30°; the gutter rises $1\frac{1}{4}$ inches in 10 feet and the drips are $1\frac{1}{2}$ inches. It has $1\frac{1}{4}$-inch gutter boards, felt covering, and 6-pound lead; the lead is to be carried up the slope of roof sufficient to give a vertical height of 6 inches. The cover flashing is to be 5-pound lead. The cesspool is to be of deal $1\frac{1}{4}$ inches thick and 9 inches by 9 inches by 6 inches deep, in the clear, lined with 6-pound lead, and covered with a flat copper-wire grating. A 4-inch 8-pound lead socket pipe is to take the discharge from the cesspool into the rain-water head.

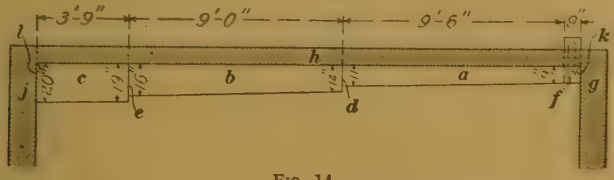


FIG. 14

SOLUTION.—By the method shown in Fig. 12 (*b*), it is found that for every inch that the gutter rises the width is increased $1\frac{3}{4}$ in. Since the first section *a* is 9 ft. 6 in. long and the rise is $1\frac{1}{4}$ in. in 10 ft., the width is increased very nearly 2 in. As the width at the narrow end is 9 in., the width at the wide end of section *a* is 9 in. + 2 in. = 11 in. As the drip *d* is $1\frac{1}{2}$ in., the width is here increased $2\frac{5}{8}$ in. This being more than $2\frac{1}{2}$ in., it is taken as 3 in. The width of the narrow end of section *b*, therefore, is 9 in. + 2 in. + 3 in. = 14 in. By the same method, the wide end is found to be 16 in. and the ends of section *c* are 19 in. and 20 in. wide.

The gutter boards and bearers are measured in three sections. The first *a* is 9 ft. 6 in. long and has an average width of $\frac{9 + 11}{2}$ = 10 in.; the second *b* is 9 ft. long and has an average width of $\frac{14 + 16}{2}$ = 15 in.; the third section *c* is 3 ft. 9 in. long and has an average width of $\frac{19 + 20}{2}$ = $19\frac{1}{2}$ in., but 20 in. is taken. Therefore, there is required

(9 ft. 6 in. × 10 in.) + (9 ft. × 1 ft. 3 in.) + (3 ft. 9 in. × 1 ft. 8 in.) = 25 ft. 5 in. super.

The same dimensions will do for felt and snow boards. Drips must be taken at *d* and *e* and the deal cesspool at *f*.

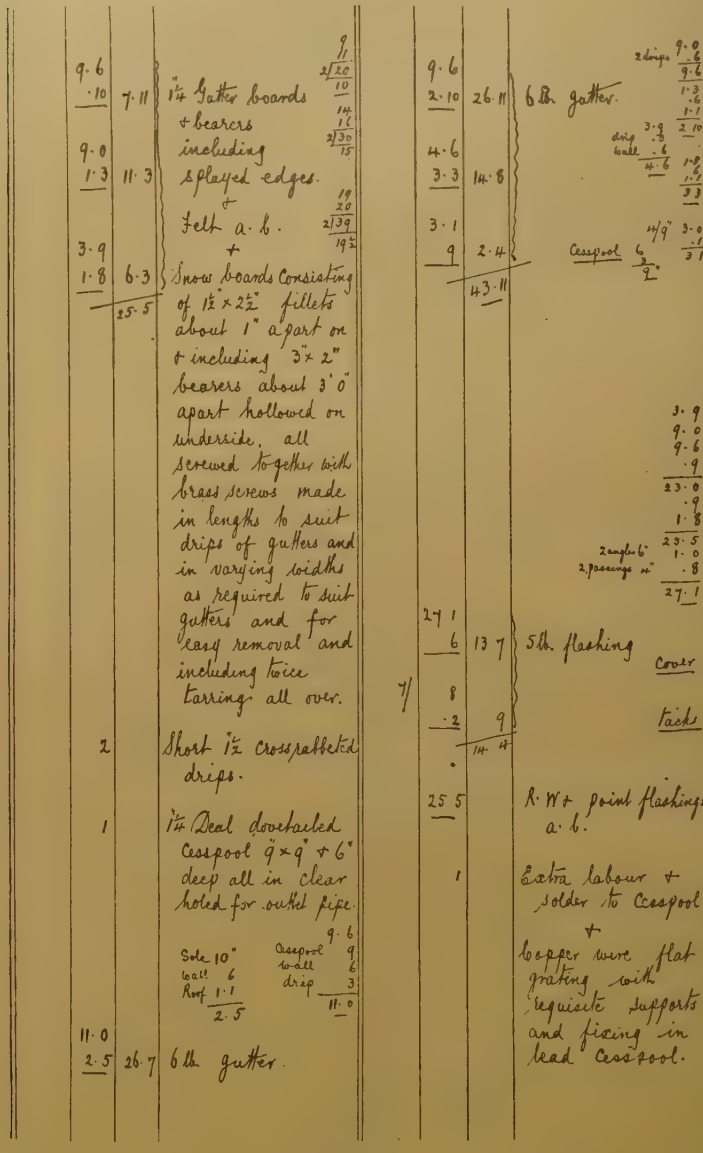

9·6 ·10 7·11 1¼ Gutter boards + bearers including splayed edges. & Felt a. b.
9·0 1·3 11·3
3·9 1·8 6·3 + Snow boards consisting of 1½"×2½" fillets about 1" apart on & including 3"×2" bearers about 3'0" apart hollowed on underside, all screwed together with brass screws made in lengths to suit drips of gutters and in varying widths as required to suit gutters and for easy removal and including twice tarring all over.
25·5
2 Short 1½ crossrabbeted drips.
1 1¼ Deal dovetailed cesspool 9"×9"×6" deep all in clear holed for outlet pipe.
Sole 10" Wall 6 Roof 1·1 2·5
Cesspool 9 wall 6 drip 3 11·0
11·0 2·5 26·7 6 lb. gutter.
9·6 2·10 26·11 6 lb. gutter.
4·6 3·3 14·8
3·1 9 2·4 Cesspool
43·11
27·1 6 13·7 5 lb. flashing Cover
7/ 8 ·2 9 Tack
14·4
25·5 R. W. + point flashings a. b.
1 Extra labour + solder to Cesspool + copper wire flat grating with requisite supports and fixing in lead Cesspool.
2 drips 9·0 ·6 9·6
1·3 ·6 1·1 2·10
drip 3·9 ·3
wall ·6 4·6 1·9 ·6 3·3
14/9" 3·0 ·1 2·1
9·6 9·0 9·6 ·9 23·0 ·9 1·8 25·5
2 angles 6" 1·0
2 passings 4" ·8 27·1

Fig. 15 (*a*)

		1	4" Diameter outlet pipe equal in substance to 8 lbs lead about 2'-6" girth twice bent one end flanged and soldered to lead lined cesspool and the other end dressed into rain water head.		1	Raking hole through 9" wall for 4" lead pipe and make good red brick facing.	

Fig. 15 (*b*)

As the lead is to be carried up the slope equal to a vertical height of 6 in., on setting out a section with a slope of 30° it will be found that the lead must go up the slope 12 in. plus 1 in. over the tilting fillet. The lead for section *a* is the length 9 ft. 6 in. plus 9 in. over the cesspool plus a 6-in. turn up next to wall *g* plus 3 in. at drip *d*. This latter is one-half the allowance of 6 in. for a drip; the other half is taken with the next length of lead. The width will be the average of the sole already arrived at for gutter boards and bearers, in this case 10 in. plus 6 in. turn up next parapet *h*, and plus 1 ft. 1 in. up slope of roof.

Section *b* must be dealt with in exactly the same way, except that, for the length of *b*, one-half the allowance for the drip at each end must be added to the net length. To the net length of section *c* must be added one-half the allowance for the drip at one end and a 6-in. turn up next wall *j*. The lead for the cesspool is the girth of the sides plus 1 in.; therefore (9 in. × 4) + 1 in. = 3 ft. 1 in. supered by the height of 6 in. + 3 in. = 9 in. The cover flashing has to be taken next; add to the clear length between walls *g* and *j*, which is 23 ft., 9 in. for return on wall *g* and 1 ft. 8 in. for return on wall *j*, being the width of the gutter at the respective points, 6 in. for each angle *k*, *l* and 4 in. for each passing, namely, two in the 23-ft. length. Taking tacks as 3 ft. apart, 7 will be required; these would be 8 in. by 2 in.. The item rake, wedge, and point for this cover flashing is the same length, less the allowances for angles and laps, that is, 27 ft. 1 in. — (1 ft. + 8 in.) = 25 ft. 5 in. A number item must be taken for the extra labour to cesspool and also for the grating. The lead outlet pipe is about 2 ft. 6 in. in girth; this allows for the pipe being jointed to the bottom of the cesspool, turned through the wall, and bent down into the rain-water head. The taking off on dimension paper will appear as in Fig. 15 (*a*) and (*b*).

EAVES, INCLUDING GUTTERS AND RAIN PIPES

97. Most of the items required under the heading Eaves, including gutters and rain pipes, are the same as for lead flats. The eaves soffit is measured per foot run. The description should give the thickness and width and describe all labours thereon ; for instance, it may be tongued to fascia, including groove. The description should state, also, if any backings are required. Any moulding under the soffit should be measured per foot run. The size should be given and the item should state whether scribed to brick or not. Take by number all mitres, ends, etc., to soffit and moulding.

TRAP-DOORS

98. Linings, Etc.—The items required for trap-doors to a great extent have been dealt with previously or will be dealt with under other main headings. The linings to opening in ceiling, etc., should be measured per foot run, unless 6 inches wide or over, when they should be measured per foot superficial. State the thickness and all labours and describe as "tongued at angles." Painting should be measured per foot superficial, as for ordinary work.

99. Curbs.—Measure curbs to trap-doors per foot run. Give the size and describe all labours on same ; they are usually dovetailed at angles. The lead to curbs should be measured as for flashings and aprons, with the same allowances.

100. Copper Nailing.—All copper nailing is measured per foot run. State whether open or *close ;* nailing 1 inch apart and under is termed **close.** If the edge of lead is bedded in white lead, the fact must be mentioned.

101. Trap-Doors. — Measure trap-doors per foot superficial. State the thickness, number of panels, and give a description of the door. If hung on butts, the doors are described as *hung.* The painting is measured per foot superficial the same size as the

door, but one-eighth is added to pay for the edges and the extra girth of the panels.

102. Lead Covering.—The lead or other covering of trap-doors should be measured as for similar work; the measurement should be the same as the door plus sufficient for going down over the edges. Bossed angles to the lead covering should be taken by number and the height given.

103. Ladders.—Take off by number all ladders. State the vertical height and give the full description of sides, or strings, and rungs, or treads, also the distance apart.

DORMERS

104. Studding to Cheeks.—The majority of items that are likely to occur in connection with dormers have been already dealt with or will be dealt with under other main headings. The studding to cheeks and under sills should be measured per foot cube. This item is generally kept separate, as it is in short lengths and very often in small scantlings. The description is "fir framed in studding to cheeks of dormers in short lengths and small scantlings."

105. Boarding to Cheeks.—When taking off the boarding to cheeks, measure per foot superficial. State the thickness and describe as "in small quantities to spandrel cheeks of dormers." Measure the boarding net; that is, the extreme both ways and deduct the wants. Take per foot run an item of "raking, cutting, and waste on -inch boarding" wherever the edges are not square.

106. Felt to Cheeks.—Felt to cheeks is taken off as described for roofs generally. Allow the length of all raking edges supered by 3 inches for cutting and waste.

107. Vertical Tiling or Slating.—The vertical tiling or slating is taken generally as directed for vertical tile hanging. State that it is "in small quantities to dormer cheeks."

108. Lead to Cheeks.—The lead to dormer cheeks and under sills, etc., is measured per foot superficial, the same as for other leadwork. The measurement is made net, as for boarding, but no allowance is made for raking edges. Additional lead must be added for welted joints, if necessary, for the lead to be in more than one piece, and for welted edge where the lead is returned on the front of the dormer.

109. Soldered Dots.—Take off soldered dots by number. State whether brass or copper screws are to be used, and include in the description an item for sinking in the boarding.

110. Welts.—Labour to welted edge and labour to welted joint should be measured per foot run. State what weight lead the labour is on.

111. Dormer Tops.—The bearers or joists, boarding, furrings, and lead to dormer tops should be measured the same as for lead flats. In the description, state, where necessary, that the items are "in small quantities to dormer tops." Where lead is dressed over the edge of nosing or moulding, an item must be taken per foot run as "labour dressing -pound lead over edge of rounded nosing, or moulding, -inch girth"; the mitres must be taken by number.

112. Cornice Externally.—Wooden cornices to tops of dormers are measured per foot run. Give the size and allow in the length sufficient for the mitres. This should be done by measuring along the extreme edge of the cornice. Take by number the mitres and splayed and fitted ends.

SKYLIGHTS AND LANTERN LIGHTS

113. Wooden Skylights.—Most of the items that occur in skylights and lantern lights have been given under trap-doors, dormers, and general roof work. Wooden skylights are measured per foot superficial. The description should state the thickness and whether chamfered or moulded; also give the distance apart that the bars are placed, and whether the bars have ordinary

rabbets at the top for glazing or are prepared for patent glazing strip.

Take per foot run all labour to splayed edges, throats, etc., and by number the sinkings in bottom rail for the escape of condensation. Patent glazing strips should be taken per foot run. Give the maker's name and address and any special section number. Describe carefully the method of fixing. The glass is measured per foot superficial. The description should state the quality and also the length, in inches, of the sheets. Copper clips and screws at the bottom should be taken by number. All painting on wooden skylights is measured by taking, per foot run, the length of all stiles, rails, and bars and multiplying this by 2 if it is painted on both sides. Describe the painting as "on skylight bars and rails."

114. Patent Glazing.—One of the many patent glazings is often used for skylights; most of them are valued per foot superficial and can be measured so. Always refer to the maker's catalogue and state clearly the section of bar, kind of glass, method of fixing, etc. If any lead flashings are required, they should be measured as previously described and the allowances added. Wherever lead is dressed down on to glass of any description, an item per foot run must be taken as follows: "extra labour and risk dressing -pound lead over glazing bars, where necessary, and down on to glass." The term risk in the foregoing description is for the risk of breaking the glass when the lead is dressed down on to same.

SUNDRIES TO ROOFS

115. Cat, or Roof, Ladders.—Measure cat, or roof, ladders per foot run. State in the description the scantling of the board and the fillets fixed to same. Any ironwork for clipping to ridge, etc., must be taken separately.

116. Ways in Roof.—The ways or runs in roofs are usually formed of ordinary roof boarding fixed to the ceiling joists or collars. They should be measured per foot superficial and the thickness given. Very often a provisional amount of boarding is specified to be included and used as may be directed.

117. Roof Ventilators.—Take off roof ventilators by number and describe very fully, as there are so many different patterns on the market. Also, clearly describe the fixing.

118. Flèches.—Flèches must be measured in detail, and all the work should be kept under a separate heading, as it is usually in very small quantities.

STONE OR CONCRETE STAIRCASES

119. Preliminary.—Before taking off any work in staircases, work out the net tread and rise of each step. The tread will be found by taking the total length occupied by the steps on plan and dividing by the number of the steps. The rise will be found by taking the vertical height to which the steps must ascend and dividing by the number of the steps. To the net tread and rise must then be added the gain for the back joint. For instance, in Fig. 16 (*a*) and (*b*), where the section through two forms of back joint is shown, an allowance must be made in each case to the tread for *a* and to the rise for *b*.

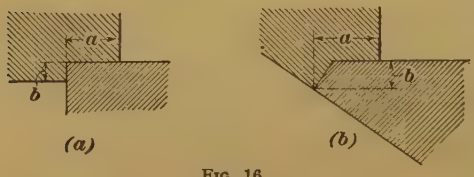


FIG. 16

120. Material.—Where the staircases are of stone, carefully describe from which quarry. Where they are made of concrete or artificial stone, describe the composition together with the special finish to treads and risers. If from a particular maker, the fact must be stated. It must be remembered that, for concrete work, moulds will be required; or if cast in position, centring must be taken.

121. Steps.—Measure the steps per foot run. State the number of steps and the size, and carefully describe all the labour on them. Spandrel steps are best taken by number. It is advisable to give a sketch, in order to show the detail of the back joint and the wall hold. Allow in the length sufficient for the wall hold.

122. Ends Cut and Pinned.—Take off by number all ends cut and pinned. State if any facing must be made good.

123. Landings.—Landings are measured per foot superficial. The description should state the thickness and whether fair on one or both sides. Where 6 feet long or over, they should be kept separate. Landings of an irregular shape are best taken by number and a sketch given. Allow in the measurement for all edges that go into the wall and additional material for any jogglejoints. When the thickness of a landing is less than the rise of the steps, it will be necessary to take a riser to make up ; measure this riser per foot run and describe generally the same as a step.

124. Edges Cut and Pinned.—When taking off, measure all edges cut and pinned per foot run. State the thickness of the edge and mention if any facing must be made good.

125. Edges.—Labour to rubbed edges and jogglejoints must be taken per foot run, stating the thickness of the stone. Also measure per foot run the rounded and moulded nosings, giving the girth.

126. Patent Treads.—There are many patent non-slipping and unwearable treads for letting into treads and edges of landings ; these would be measured per foot run or by number, according to the maker's catalogue.

127. Balusters and Newels.—Plain wrought-iron balusters and newels are measured per foot run, stating the size, but they are afterwards billed in hundredweights, quarters, and pounds. Allow sufficient, in measuring, for ends mortised into steps, etc., and for framing at top to core rail or hand rail. Take by number the ends fixed to the core or hand rail and describe the special method of fixing. Painting should be measured per foot run. All ornamental wrought- or cast-iron balusters and newels should be taken by number. Describe fully and include for fixing at top. The painting should be measured according to number. The mortises in steps and landings should be taken by number.

The description should state the size of bar the mortises are for, and whether run with lead, cement, or sulphur.

128. Core and Hand Rails.—Measure core and hand rails per foot run. State the size, allowing sufficient in measuring for ends caulked in wall, etc. Take off by number all caulked ends and any special forgings in the shape of bends, ramps, wreaths, scrolls, etc. Painting should be measured per foot run. Hand rails of wood should be measured as directed for ordinary wooden staircases.

129. Hand-Rail Brackets.—All hand-rail brackets should be taken off by number and fully described. The item should state for what kind of hand or core rail the bracket is to be used and the method of fixing the hand or core rail to same. Take by number the ends cut and pinned and state what facing must be made good. The painting also should be taken by number.

FENCES AND GATES

130. Fences.—Though fences are taken off per foot run, they are sometimes reduced and billed in linear rods of $16\frac{1}{2}$ feet. The different parts should be fully described and their sizes given ; also include for, or take by number, the digging of post holes.

131. Gates.—Gates should be given by number, fully described, and, if necessary, a sketch given.

OPENINGS AND RECESSES HAVING NO JOINERY

132. Deductions.—The method of taking off the deductions of brickwork, facing, and plastering for openings and recesses having no joinery varies with the kind of arch used. If it is a segmental arch with a small rise, the width multiplied by the height up to the springing line is the correct amount ; but if a semicircular arch is used, it is necessary to measure the height up to the springing line as one dimension and the semicircular portion as another.

133. Arches. — Rough segmental and semicircular arches are taken by number. The description should give the span, width on soffit, and the number of rings. It should also state whether or not they are in $\frac{1}{2}$-brick rings. If the brickwork is in mortar, the arches should be described as in cement. All cutting should be included in the description. *Fair* arches of every description are measured per foot superficial. The term fair is applied to all arches in facework. The superficial measurement is found by measuring the average girth on the face supered by the height plus the area of the soffit of the arch, and described as "extra over the common brickwork." The girth of the soffit of a segmental arch may be roughly found by adding 3 inches to the width of opening or recess, and the average girth of the face by adding 6 inches to the width of the opening or recess. This method is not always correct, for each arch will vary with the rise, but it is near enough for general practice. The description of fair arches must state whether they are fair axed or rubbed and gauged; also whether or not they are in $\frac{1}{2}$-brick rings. Flat, segmental, semicircular, and bull's-eye arches should be kept separate. All facing displaced by the arch must be deducted.

134. Cuttings for Arches. — Cuttings to all fair arches are taken off per foot run. Skew backs are described as "fair cut skew back"; and extrados, as "fair circular cutting." Skew-back cutting to an arch 9 inches high on the face is usually taken as 10 inches. To find the extrados cutting for a segmental arch, it will generally be near enough to add 9 inches to the width of opening or recess.

135. Centres for Arches.—To support the arches while they are being built and until set, *turning pieces*, or *centres*, must be measured. **Turning pieces** are pieces of boards or other rough timber cut circular on the edge to fit the soffit of the arch; they are measured to flat and segmental arches that are less than 9 inches thick on the soffit. **Centres** are built up of pieces of timber to which fillets are nailed as required to suit the thickness of the arch. These are measured to all arches except where turning pieces are taken. Turning pieces are measured per

foot run. The net width of the opening is measured as the length for turning pieces and the thickness on the soffit is given. Centres are taken by number for bull's-eye or pointed arches, the width of opening and thickness on the soffit being given. Centres are measured per foot run for arches under 9 inches thick on the soffit, the length being the girth of the soffit of the arch; the thickness on soffit must be stated. The centres are measured per foot superficial for arches 9 inches thick on the soffit and over, the measurement being the girth of the soffit of the arch by the thickness on the soffit. Where keystones to arches project below the soffits of the arches, there should be taken by number an item " notchings in centring for keystones."

136. Flooring in Openings.—Where brickwork has been deducted, it will be necessary to add floor or paving for the opening so formed. Floor or paving should be measured as before directed, but deal floor, where on joists, should be described as " floor as before, including bearers in openings."

137. Reveals.—The skirtings must be deducted where not required and the additional portions added for the reveals. Facing or plastering must be measured for the reveals. The facing should be added to the ordinary, but the plastering, if 12 inches wide or under, should be separated as " in narrow widths to reveals." Plastering should be measured in a similar way to the soffit of a rough arch and described as " in narrow widths circular to soffits."

138. Angles.—External angles in brick or plaster should be measured per foot run and described fully; they should be separated when they are to the circular edges of arches. Angles in plaster are generally made in Keene's, or some other hard-setting cement. These should be described as " extra over ordinary plaster," and the angle described as an arris, or as slightly rounded, rounded -inch girth, staff beaded, moulded -inch girth, etc. All mitres, stops, junctions of circular and straight, etc., should be taken by number. When plaster angles are moulded or boldly rounded, the rough brickwork must sometimes be chamfered; in this case, measure per

foot run as "rough-cut chamfer on brick about inches wide."

EXAMPLE 1.—Take off all the work in connection with the opening shown in Fig. 17, where (*a*) is the elevation and (*b*) is the plan. The opening is in a $1\frac{1}{2}$-brick wall faced on one side with red-pressed bricks and on the other with picked stocks. Blue-brick quoins having a bullnose angle to a $2\frac{1}{4}$-inch radius are used to 6 feet above the floor, which is granolithic, usually abbreviated grano., $1\frac{1}{2}$ inches thick.

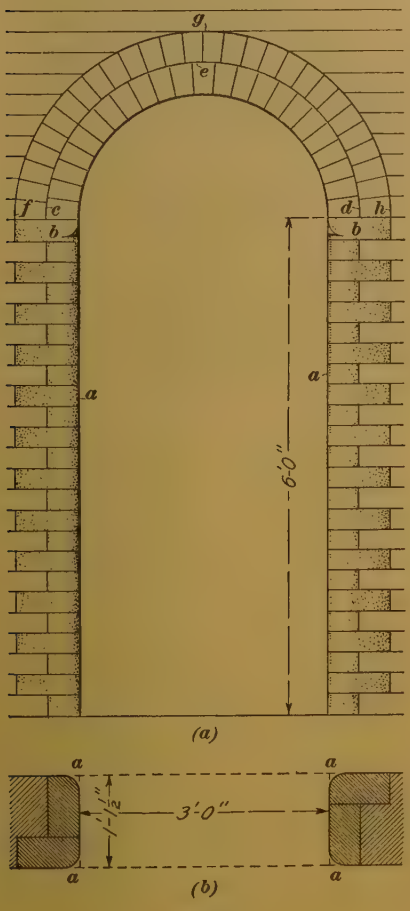


FIG. 17

SOLUTION.—To find the amount of brickwork to be deducted, the opening should be divided into two parts. That portion below the springing line contains 6 ft. × 3 ft. = 18 ft. super. of $1\frac{1}{2}$-brick wall; that portion above the springing line contains the area of one-half a circle of 3 ft. diameter, which equals 3 ft. 6 in. super. of $1\frac{1}{2}$-brick wall. These are also the dimensions required for the deduction of red pressed-brick and the picked-stock facings. As the quoins are to be in blue bricks, the stretchers showing on one face will show headers in the reveals, but the courses on the other face that are level with these will show headers, while the stretchers will be in the reveals. Consequently, the whole of the reveals will be in blue bricks. To find the blue facing, multiply the width $13\frac{1}{2}$ in., which is 9 in. + $4\frac{1}{2}$ in., by the height 6 ft.; then multiply this by 2 for both reveals. That part which shows on the faces which is alternately 9 in. and $4\frac{1}{2}$ in., or an average of $6\frac{3}{4}$ in. by the height 6 ft., must be multiplied by 2 for both reveals, and again by 2 for both sides. For this last dimension, deduction from the general facing on either

side of the wall must be made so that half the dimension will be a deduction from red facing and the other half from picked-stock facing.

The bullnose angles *a*, Fig. 17, will be the height of 6 ft. as extra over the blue facing last measured with the stops *b* numbered, as the stop-bricks cost more than the ordinary bullnoses.

The soffit of the arch will be alternate headers and stretchers in red and picked bricks. As the arch is in $\frac{1}{2}$-brick rings, this means that certain of the headers must be snapped to allow of bonding with the other kind of bricks. In Fig. 18 is given a plan of the soffit, looking up, the shaded bricks being red and the remainder picked stocks. This shows that one-half of the soffit will be in red and the other half in picked bricks. The girth of the soffit is the width of the opening, treated as the diameter, multiplied by $3\frac{1}{7}$, to get the circumference, and divided by 2, as it is only one-half a circle. This girth by half the thickness of the soffit $6\frac{3}{4}$ in. is the area for the soffit of the arch in red bricks and also in picked stocks.

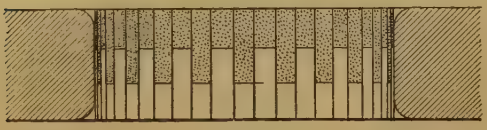


Fig. 18

The centring will be the same girth on the soffit by the full thickness of the soffit, namely, 1 ft. $1\frac{1}{2}$ in.

The dimension for the face of the arch will be the same for both sides and also for the deduction of both kinds of facing displaced by the arch. This dimension will be the average girth on the face by the height of the arch. The average girth on the face is found by taking the net width of the opening plus the height of the arch as the diameter of a semicircle. This is equal to measuring along the line *c e d*, Fig. 17 (*a*). The height in this case is 9 in., which is equal to two $\frac{1}{2}$-brick rings.

The measurement for cutting to the extrados of the arch on both faces must be taken on the line *f g h*, Fig. 17 (*a*). Take the net width of opening plus twice the height of arch as the diameter of a semicircle. The foregoing cutting only includes a $4\frac{1}{2}$-in. thickness, so that after taking it on both faces there is still left a $4\frac{1}{2}$-in. thickness in the middle to make up the total thickness of the wall; this should be taken as rough cutting. The dimension will be the same as the last supered by 5 in. The addition of paving is just the width of opening supered by the thickness of wall. The taking off of this example will appear on the dimension paper as in Fig. 19.

Example 2.—Take off all work in connection with the recess shown in Fig. 20, where (*a*) is the elevation and (*b*) the plan. The wall is finished fair face and twice limewhited; the angles are bullnosed, with a $1\frac{1}{8}$-inch radius to 6 feet above floor, which is granolithic $1\frac{1}{2}$ inches thick.

Solution.—The deduction of brickwork will be the width of the recess supered by the height up to the springing of the arch. The fair face and

limewhite will be equal on the face, but must be added for the reveals. The dimension is $4\frac{1}{2}$ in., which is called 5 in., supered by the height

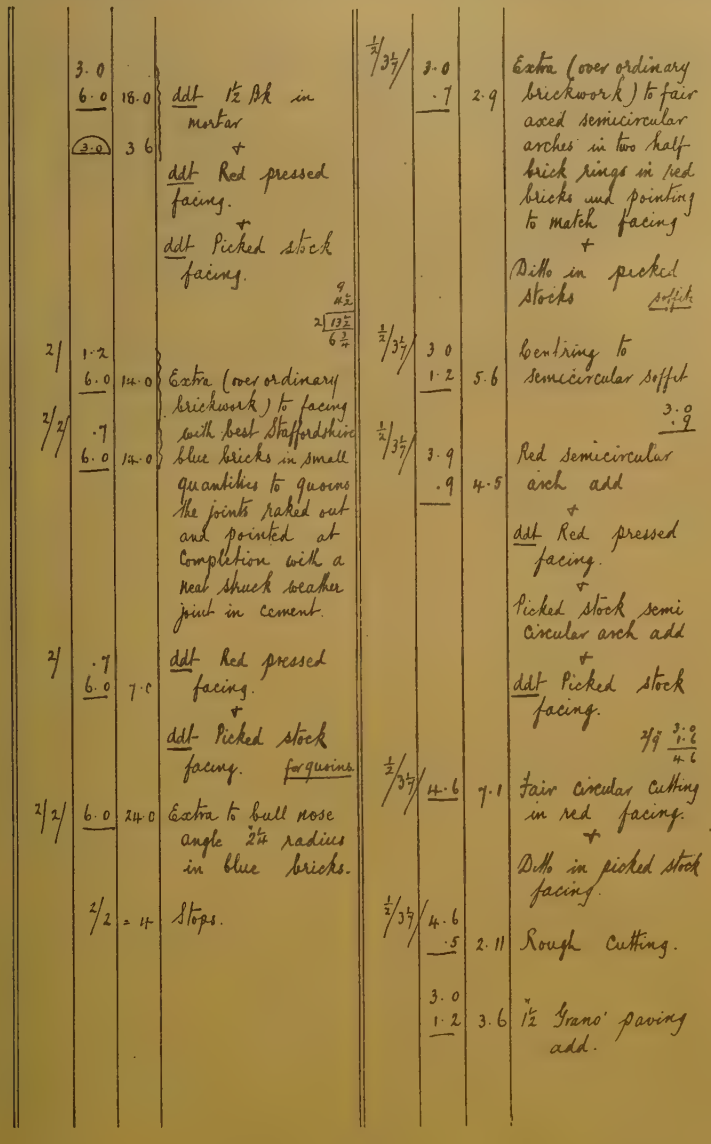

3.0
6.0 18.0 ddt 1½ Bk in mortar
3.0 3 6
ddt Red pressed facing.
ddt Picked stock facing.
2/ 1.2
6.0 14.0 Extra (over ordinary brickwork) to facing with best Staffordshire
2/2/ .7
6.0 14.0 blue bricks in small quantities to quoins the joints raked out and pointed at completion with a neat struck weather joint in cement.
2/ .7
6.0 7.0 ddt Red pressed facing.
ddt Picked stock facing. for quoins
2/2/ 6.0 24.0 Extra to bull nose angle 2¼ radius in blue bricks.
2/2 = 1 Stops.
1/3½/ 3.0
.7 2.9 Extra (over ordinary brickwork) to fair axed semicircular arches in two half brick rings in red bricks and pointing to match facing
Ditto in picked stocks soffit
½/3½/ 3 0
1.2 5.6 centring to semicircular soffit
3.0
.9
½/3½/ 3.9
.9 4.5 Red semicircular arch add
ddt Red pressed facing.
Picked stock semi circular arch add
ddt Picked stock facing.
3/9 3.0 1.2 4.6
½/3½/ 4.6 7.1 Fair circular cutting in red facing.
Ditto in picked stock facing.
½/3½/ 4.6
.5 2.11 Rough cutting.
3.0
1.2 3.6 1½ Grano' paving add.

Fig. 19

of 7 ft. × 2. The bullnose angle will be the height of 6 ft. × 2 with the stops numbered. The soffit of the arch is the width of recess, 3 ft., + 3 in. for the gain supered by 5 in. This dimension must also be taken for the limewhite. The dimension for the face of the arch will be the width of recess, 3 ft., + 6 in. for the gain which equals the average girth measured on line *a b* supered by the height of 9 in.; this dimension can also be used for the deduction of fair face displaced by the arch. The turning piece is the width of recess, namely, 3 ft. The skew-back cutting for the arch is 10 in. × 2, and the circular cutting to extrados is the width of 3 ft. + 9 in. for the gain. The addition of paving is the width of recess supered by the depth of the recess, namely, 3 ft. × 5 in. The taking off on dimension paper is shown in Fig. 21. The last item in the first column means "twice limewhite."

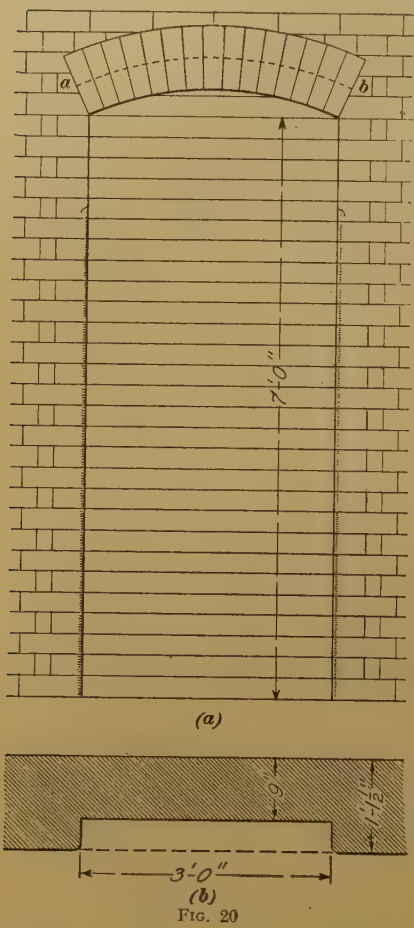


FIG. 20

EXAMPLE 3.—Take off all work in connection with the opening shown in Fig. 22, where (*a*) shows the elevation and (*b*) the plan. The opening is in a 9-inch wall plastered on both sides with Portland-cement flush-beaded skirting 9 inches high. The angles are in Keene's cement, slightly rounded. The floor on both sides of the opening is 1-inch deal, grooved and tongued. The plaster work is to be twice distempered to an approved tint.

SOLUTION.—The only work that may need explanation in this example is the plastering. First deduct the skirting for the opening and then add the lengths required for the jambs *a*, which will be the thickness of wall plus the two thicknesses of plaster, namely, $\frac{3}{4}$ in., on each side. The angles *b* being slightly rounded, they must be taken by number. The deduction of plastering on both sides is the width of the opening by the

height to springing less the height of skirting, or 7 ft. 6 in. — 9 in. = 6 ft. 9 in. The reveals must be added, and they will be the width, which is made up of the thickness of wall plus the two thicknesses of plaster, namely, 9 in. + ($\frac{3}{4}$ in. × 2) = $10\frac{1}{2}$ in., supered by the same height as last. The plastering to the soffit of the arch is the width of the opening plus 3 in. for the gain of arch supered by the thickness of the wall plus two thicknesses of plaster, so the dimension would be (3 ft. 6 in. + 3 in.) × [9 in. + ($\frac{3}{4}$ in. × 2)], the latter measurement which equals $10\frac{1}{2}$ in. would be taken as 11 in. The slightly rounded

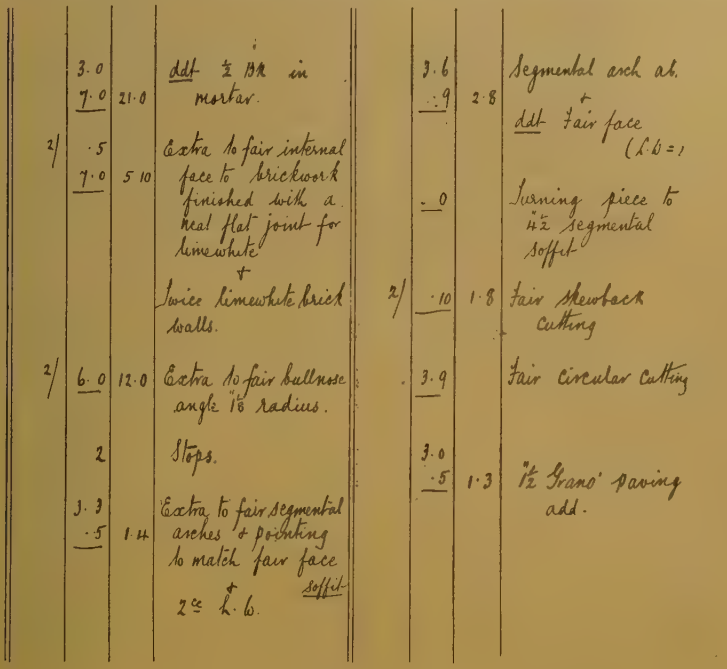


Fig. 21

external angles *b* are in Keene's cement; these must be measured as extra over the ordinary plastering. The length will be the same as the height of the plastering to the reveals. This angle must also be taken to the edge of the arch, and the junctions *c*, where the vertical meets the circular, are taken by number. Where, in different plaster from the usual wall plastering; angles must have returns, usually about 2 in. wide on each side of the angle, this displaces the same width of ordinary plastering, so the angles are described as "extra over plastering." The dimensions for this example would appear as in Fig. 23. The item "2 ✓ dist. a tint" means "twice distemper a tint."

JOINER'S WORK

139. Thicknesses.—The thickness given for joiner's work is usually the thickness of the wood from which the article is produced; therefore a 2-inch door will measure, when finished, less than 2 inches because of the planing. If it is intended that the thicknesses given are to be the thicknesses when finished, special care must be taken that the work is described as "finished sizes." This question is the cause of much trouble; therefore, to avoid unpleasantness, this point should be made quite clear in the specification and the quantities.

FIG. 22

140. Tenons.—In measuring doors, framings, etc., as finished framings, nothing extra is allowed for the tenons; but where measuring work in detail, for instance, the frames, transoms, mullions, etc., of a window, allowance must be made in the length for the framing.

141. Widths.—All deal 10 inches wide and over must be described as cross-tongued. Hardwoods can be obtained in greater widths and are not usually described as cross-tongued unless over 15 inches wide.

142. Fixing.—Work which has to be screwed instead of nailed, or secretly fixed or fixed with brass cups and screws, must

	3.6 7.6	26.3	ddt 1 Bk in mortar.
	1		Extra to rough segmental arch over opening 3'.6" wide + 9" soffit in two half brick rings in cement including all cutting
	3.9 .9	2.10	Centring to segmental soffit.
	3.6 .9	2.8	1" Deal wrot grooved + tongued flooring a.b. including bearers in opening.
2/	3.6	7.0	ddt Portland cement flush beaded skirting on brick 9" high trowelled smooth + (4s 2/3/4" 9"/2 10½
2/	.11	1.10	add ditto + (4s.
	2/2	= 4	Slightly rounded external angles.

2/	3.6 6.9	47.3	ddt sktg 7.6 / 9 / 6.9 Render float + set walls + 2ce distr a tint.
2/	.11 6.9	12.5	R.F + S in n.w's to reveals + 2ce distr a tint.
	3.9 .11	3.5	R.F + S in n.w's circular to soffit + 2ce distr a tint
2/2/	6.9	27.0	Extra over plastering to Keene's cement slightly rounded external angle and two 2" returns.
2/	3.9	7.6	Do circular to edge of arch
	2/2	= 4	Junctions of circular and straight.

FIG. 23

be so described. Deal which is to be stained must be described as "selected and kept clean for staining and varnishing."

143. Circular Work.—All circular work must be separated. Where circular on plan, state the radius. As there are many kinds of circular work, it is necessary to state what is intended; for instance, work cut circular on one or both edges, work bent in fixing, work glued up in thicknesses, etc.

144. Labours. — In describing labour to edges of wood, separate any that are *cross-grain*, that is, worked across the grain. *Splayed edge* is when the whole thickness is worked, and *chamfered edge* when only part. Scribing is measured when woodwork abuts against brickwork, but not where it abuts against plaster. The edges of all joinery adjoining brickwork, where there are no grounds or fixing bricks, must be described as "plugged." This plugging should be measured per foot run in cases where the joiner's work is measured per foot superficial. Notching must be taken for all work that is fitted round a projection, such as a pier or other projection; the girth must be measured and the thickness of the wood stated.

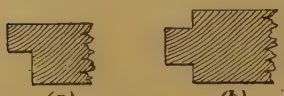


FIG. 24

The term *tongued* is very often misunderstood; an item that is described as tongued is generally held to mean the labour forming the tongue and also the groove to receive it; but to avoid misunderstanding, it is as well to state "tongued, including groove." Note that Fig. 24 (*a*) shows a rabbeted edge and (*b*) a tongued edge.

The terms *chamfered*, *rabbeted*, *moulded*, etc., mean once chamfered, etc.; if the labour is on more than one edge, it must be stated; for instance, "4″ × 3″ wrought-framed rabbeted, beaded, and twice-moulded frame" would be the description for the frame *a* shown in Fig. 25.

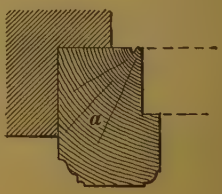


FIG. 25

145. Mouldings.—It should be clearly stated in the joiner's bill whether the mouldings are to be made to detail drawings or whether machine-made stock mouldings will be accepted.

146. Framings.—Describe both sides of a piece of framing, except in the case of a square-framed door, which is understood to mean square framed on both sides. It is usual to describe all doors and framings under 5 feet in height as *dwarf*, except window backs. Framing with small or irregular panels must be kept separate and fully described. Framings of irregular shapes are best measured *net*; that is, measure the exact superficial quantity and state that they are so measured.

147. Method of Measurement.—It is often difficult to determine whether items are to be measured per foot superficial, per foot run, or per number; but since it is the object of quantities to measure the items so that they may be easily valued, they should be so taken that the process of valuing will be as simple as possible. Therefore, items that contain much labour should be taken per foot run rather than per foot superficial. As a general rule, ordinary linings, window boards, etc., over 3 inches wide can be taken per foot superficial; but there is not any very great objection to measuring per foot run items up to 8 or 9 inches wide, if by so doing the amount of labours can be more easily valued. Work in small quantities or short lengths must always be kept separate. Work of small size with much labour on it is best taken by number, with a sketch showing what is required.

IRONMONGERY

148. Method of Measurement.—All ironmongery is taken by number, by pair, or by set. The description should state whether it is iron, brass, gunmetal, etc., and give as much information as possible. The better way is to provide a prime-cost sum for each article, or select the articles from a manufacturer's list and state the catalogue number and list price. List prices must only be used when the manufacturer's name is stated, as catalogue or list prices are subject to percentages that vary greatly. If the manufacturer is not decided on when the quantities are prepared, the prices should be prime cost, or p.c., and the estimator will then add to the price given not only for fixing, etc., but also for profit. The measurements are: *Butts*, the vertical height;

cross-garnet and strap hinges, the length of strap is measured from the *knuckle*, that is, the portion fixed to the door; *rim, mortise, and drawer locks, latches, etc.*, the horizontal length; *cupboard locks*, the vertical height; *bolts*, the length of bolt, not the length of plate; *lock furniture*, diameter of knob.

149. Fixing.—Ironmongery must include for fixing and also for the necessary screws; unless otherwise specially arranged, screws are not included in the prices given. Fixing to hardwoods must always be kept separate from that to deal; pitch pine is taken as a hardwood.

GLAZIER'S WORK

150. Method of Measurement.—Glass is known by its quality and weight or thickness. It is usually kept in squares, which vary in size every 2 feet superficial. All glass is measured per foot superficial from rabbet to rabbet. Any part of an inch is taken as the next inch. Irregular pieces are measured square; circular edges are measured per foot run and described as "circular cutting and risk on glass." Glass that is glazed to metal, in wash leather, etc., to door panels, and that glazed with beads are kept separate. Glass that is bent circular on plan must always have the radius given. It does not always follow that a window which is circular on plan is to have the glass bent circular.

151. Lead Glazing.—Lead glazing is measured per foot superficial and is usually included at a prime-cost sum per foot. The estimator adds for supply of templates, profit, packing, carriage, delivery, and fixing, and, where necessary, tying to saddle bars State whether it is to be fixed to wood, stone, or metal.

152. Saddle Bars.—Sometimes the price of lead glazing includes the saddle bars, but more often than not they must be measured separately. Take them per foot run and state the size and whether wrought iron or copper, etc. Include sufficient in the length for going into the mortises about 1 or $1\frac{1}{2}$ inches at each end. Painting should be measured per foot run; mortises for the ends of the saddle bars should be taken by number and the kind of material in which the mortise is made should be given.

PAINTER'S WORK

153. Painter's work is generally measured per yard superficial. The description should state the number of coats in addition to the priming; for instance, "knot, stop, prime, and paint four coats in addition to priming on woodwork." Paint should always be measured at the same time as the item which is to be painted. An allowance has to be made over the superficial measurement of a door or framing, etc., for the edges and the extra girth of the panels; this is done by dividing by 8, to bring to yards superficial, instead of by 9, and is entered on the dimensions as "$\div 8$"; this is equal to adding one-eighth.

Painting on windows is measured by taking the frames and the squares by number and multiplying by 2 for both sides, where the painting inside and outside are alike. Frames over

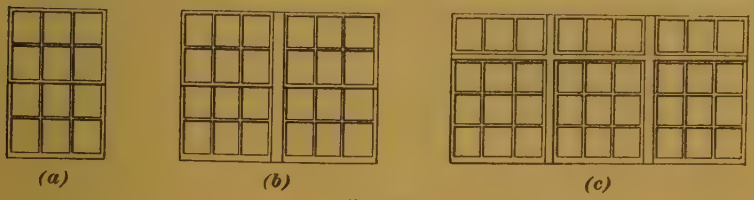


FIG. 26

24 feet superficial are described as *large*, and those over 36 feet superficial as *extra large*. Frames are always taken as one light unless otherwise described; when they have a transom, the fact must be stated. In Fig. 26 (*a*) is shown a frame, in (*b*) a two-light frame, and in (*c*) a three-light frame with transom.

Squares over 2 feet superficial are termed *large*. Where sashes are in one square describe them as *sheets*, over 8 feet superficial as *large*, and over 13 feet superficial as *extra large*. Sashes which are hung on butts or centres must have an item taken for the edges by number, termed *casement edges*.

154. French Polishing.---French polishing on general surfaces is measured per foot superficial. Very often french polishing is included with the items to be so treated; this method is very satisfactory, as the estimator then has some idea of the nature of the work. It must be remembered that polishing is not done

with a brush; therefore narrow, moulded, and awkward pieces are much more costly than plain surfaces, and so should be measured per foot run or by number.

155. Writing.—All lettering is measured per inch of the height of the letters; for instance, twelve letters 3 inches high are entered and valued as 36 inches of writing. Always state whether the writing is plain or ornamental.

WINDOWS

156. Deductions.—Brickwork must be deducted first for external opening and then for internal opening. It depends on whether the windows are in the outer or the inner reveals as to which deduction will be the larger. For deal-cased frames, the deduction where the frame is will generally be 9 inches wider and 3 inches higher than the deduction for the other reveal; but usually a detail is given showing which reveal is required. For casement windows, the deduction where the frame is will vary according to the size of the frame and the amount of frame that is exposed. The dimension for the deduction for external opening will also do for the deduction of external facing, rough cast, etc., and the deduction for internal opening is the same as that for plastering or other internal wall finishing.

157. Key Blocks.—When stone key blocks are used with brick arches they are best taken by number.

158. Stone Dressings.—Stone dressings to heads, jambs, sills, etc., should be measured as directed for stonework generally. They must be taken off by the same system that was used for taking off the other stonework in the job, if any. Brickwork and facing must be deducted for the stonework in the usual way.

Where the stone jambs are unattached to other stonework, as the quoins in Fig. 27, it is usual to take the vertical height from the top *b* of the sill to the top *a* of the head as "cutting on facing up to stone dressings." This height is taken to the under side *c* of the sill if the facing and brickwork have been deducted for the sill; but generally this is done only for large sills

159. Window Sills.—The sills to windows in brick facing that have no other stone dressings are measured per foot run. The description should give the width and thickness and should carefully describe all labours on the stone. The length is the width of the external opening plus $2\frac{1}{4}$, 3, or $4\frac{1}{2}$ inches at each end in the wall, according to detail. The width of the sill will vary according to the detail, but a window in an inner reveal generally has a sill 6 inches wider than the depth of the outer reveal; so that for a window with a $4\frac{1}{2}$-inch outer reveal, the sill should be $10\frac{1}{2}$ inches wide. The 6 inches is for the projection beyond the face of the wall, about $1\frac{1}{2}$ or 2 inches, and the remainder for going in under the wooden sill of the window frame to allow for the iron tongue. Take by number the fair stooled ends with stop to the throat.

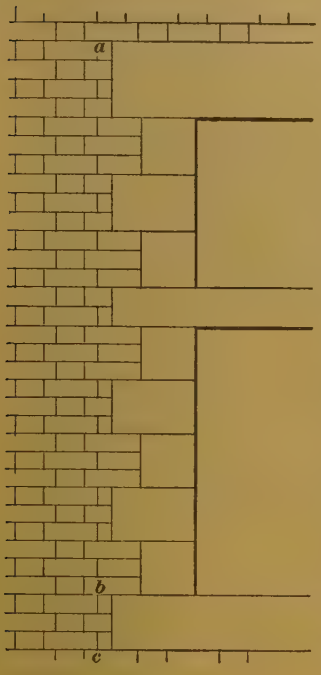


FIG. 27

Brickwork or facing is not deducted for the sills, and really no claim can be made for the ends built in the wall, but usually an item is taken, by number, of "make good facing to ends of window sills."

160. Aprons Under Sills.—Brick aprons under sills are measured per foot superficial, the same as for external facing; and where in different bricks from the adjoining facing they are described as "in small quantities in aprons under window sills." The extra brickwork for the projection must be added, and the deduction of the ordinary facing made for that displaced by the apron. To the vertical edges, and also to the bottom, where square, an item per foot run must be taken of "narrow return inches wide and pointing to edges of aprons." Where

the bottom edge is curved or ornamental, take the girth per foot run and describe. In cases where the aprons are very ornamental and executed in rubbers, it will be much better to take the aprons by number as extra labour and material over the general facing; give a sketch showing the outline and include for the cutting on the general facing up to the apron.

161. Fixing Bricks or Fillets.—Wooden fixing bricks or fillets or coke-breeze fixing bricks are required for fixing the frames, etc., to the brick reveals; they should be taken by number, and the number required to each reveal will vary according to the height; unless it is specified to the contrary, take one 12 inches above the bottom of the opening and one every 2 feet above this. Describe the coke-breeze fixing bricks as "extra over ordinary brickwork."

Frames fixed to stone should have lead plugs, mortises, and screws the same distance apart as for fixing bricks or fillets; but before taking them, one must be sure that this fixing is really intended, as it is an expensive method and very often ordinary wedging is considered sufficient.

162. Frames Bedded and Pointed.—The item of bedding and pointing frames should be taken by number, keeping separate those bedded and pointed against stonework. Those over 24 feet superficial are termed *large* and those over 36 feet superficial *extra large*. This item is only taken for doors and windows in external walls and in internal walls that have no linings or plastering.

163. Fir Lintels.—Fir lintels are measured per foot cube; they are 6 to 9 inches longer at each end than the width of the opening. They should have a thickness of 1 inch to every foot of span, but should never be less than 3 inches thick.

164. Relieving Arches.—Relieving arches over lintels should be measured and described in the same manner as other rough arches, but they should be kept separate from them on account of the extra cutting to the intrados. Observe that the span of the arch is the extreme length of the fir lintel and not the width of the opening. Centring is not required.

165. Concrete Lintels.—Concrete lintels should be measured per foot run. State how many lintels the length represents. Usually allow a $4\frac{1}{2}$- to 6-inch bearing at each end beyond the width of opening. Describe the composition of the concrete, give the width on the soffit and the height, and include for moulds, hoisting, and setting. Where the cores are small tees or angles, they can be included with the lintel by stating the section to be used and the number to each lintel. Where the cores are steel joists, they are best measured separately, kept distinct in the bill from other steel joists, and described as "in cores to concrete lintels and hoisting and fixing at various levels." When this is so, the description of lintels must be amplified to read "the steel-joist cores are measured separately." Brickwork is not usually deducted for lintels, but the description should state whether or not this deduction has been made.

166. Metal Tongues.—Metal tongues are measured per foot run. The item should state the width and thickness; the length is the same as the width of the opening which is to receive the frame. The tongue requires two grooves, one in the stone sill and the other in the wood. The best way is to state in the description of the respective sills "grooved for metal tongue"; otherwise, the groove must be taken per foot run.

167. Sashes and Frames.—Where the windows have cased frames and sashes, they are measured per foot superficial, fully described in every detail, and sundry extra labours, where necessary, measured in addition. Casement windows, however, are measured in detail; the sills, frames, mullions, and transoms are taken per foot run and the sashes or casements per foot superficial.

168. Wooden Sills.—Wooden sills which occur to casement windows, dormers, lantern lights, etc., are usually in hardwood, either teak or oak, and should be measured per foot run. The description should state the scantling and describe all the labours; these sills are usually termed *framed*. Where in long lengths, include for hand-rail joint screws in the length. Ends

which are exposed should be taken by number as "fair ends." Angles which will occur to bays, etc., should be taken by number as "framed and mitred angles, including hand-rail joint screws." Where the angles are irregular, it must be stated. Outlets for the escape of condensation *a*, Fig. 28, should be taken by number and the length stated. In measuring the length of sills for bays, care must be taken to measure to the extreme edge of the angles every time and not along the centre line. Sills which are circular on plan are best measured net, the estimator making allowance in the price for waste in converting. The radius should be stated; for instance, "7″ × 3½″ (net) teak, wrought, framed, sunk, weathered, and throated sill grooved for metal tongue; circular on plan to 8′ 6″ radius, including hand-rail joint screws."

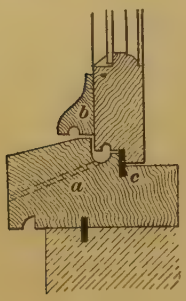


FIG. 28

169. Frames, Mullions, and Transoms.—The *frames*, which term is understood to include the jambs as well as the heads, and the mullions and transoms are measured per foot run. The description should give the scantling and describe all the labours thereon; these would be termed *framed*. In measuring the length, allow sufficient for the framing. This means that the jambs and mullions should be measured from the under side of the wooden sill to the top of the head, and the heads and transoms to the extreme of the jambs. Work circular on plan or elevation must be separated and measured net. Heads to semicircular or pointed heads must include hardwood keys and wedges. Heads which are cut circular on one or both edges to fit the soffit of a segmental arch must be so described.

170. Sashes.—The sashes or casements are measured per foot superficial. State the thickness and whether moulded or chamfered; also if fixed, hung on butts or centres, hung folding, and in how many squares. Add 1 inch to the width for folding casements. Sashes of irregular shapes are generally measured as if they were square; they should be separated and the description state whether they are spandrel shaped, segmental or semicircular

headed, etc. State at end of the description "measured square." Measure per foot run such additional labours as rabbeted and beaded, or other meeting stiles, also the labour to bottom edges and stiles according to detail.

171. Sash Beads.—When the frames are not rabbeted for the sashes, beads are planted on to form the rabbets. This is the usual way for centre-hung sashes and sometimes for ordinary sashes. These beads should be measured per foot run, and for centre-hung sashes should be described as "cut and mitred sash beads," as they are partly fixed to the frame and partly to the sash.

172. Weather Fillets.—Weather fillets *b*, Fig. 28, and weather bars *c* are measured per foot run. Give the scantling and method of fixing; also include with the weather bar the groove in the sill, and state if it is to be bedded in white lead.

173. Metal Casements.—Measure metal casements by number, giving the size and stating the manufacturer's name, also the section number; or else include each at a prime-cost sum. In either case, ironmongery must be included for those that open. Fixing only should be taken by number, giving the average size and stating whether to wood or stone. Include for the screws, and, for stone, the lead plugs and mortises. The holes drilled in the casements are usually done before they are delivered. Painting is taken by number, the average size and the average number of squares being given. Separate opening casements from those that are fixed; where the painting is the same on outside and inside, describe as "on both sides."

174. Cased Frames and Sashes.—Cased frames and sashes are taken off per foot superficial, the measurement being the same as the deduction of the brickwork to form the opening to receive the window. Describe fully the frames and sashes, giving the thickness of inner and outer linings; if not plain, describe the labour, whether beaded or moulded. State the thickness of back linings, pulley stiles, and head; also parting beads and slips. The size of sill must be given, and the description should also state whether the sill is of teak or oak and give all the labours on same. The thickness of sashes must be given, stating whether

they are moulded or chamfered and the number of squares, with the thickness of bars. State whether the sashes are single- or double-hung, also what weights, lines, and pulleys. If the bottom bead is extra deep for ventilation, it must be stated and the size given ; also state any labour to bottom edge of sashes or at meeting rails. These last items are sometimes measured per foot run as extra over the frames and sashes ; but as they must be executed at the same time as other parts of the frame, they are best included in the description. If the sills project beyond the face of the outer linings, the total width of sill must be given. Sashes which are to be glazed with plate glass must be described as " with lead weights, if required, for plate glass."

Windows under 16 feet superficial must be kept separate, and the number given as well as the superficial feet. Windows of two lights or more in width are separated and the mullions described, whether boxed or solid. Windows with transoms must have the transom described and the method of hanging the sashes below and above the transom given ; a sketch also may be very useful. Windows circular on plan must be separated and the radius given ; windows with segmental or semicircular heads should be measured square and this stated in the description. Care must be taken to describe whether the frames or the sashes, or both, have segmental or semicircular heads.

175. Moulded Horns.—When taking off moulded horns by number, state to what thickness of sashes. When used, they are always to the top sashes, but sometimes they are specified to both top and bottom.

176. Ironmongery.—The ironmongery required for casement windows will be butts or centres, casement fasteners, casement stays, and sets of lines, cleats, etc., to top sashes or sets of opening apparatus. Butts are always taken per pair and also centres. Note that a pair of sash centres consists of two centres and two plates, so that one pair is required for every centre-hung sash. For cased frames and sashes, the ironmongery consists of sash fasteners, sash lifts to bottom sashes, pull-down handles to top sashes, and sets of handles, pulleys, etc., for opening and closing top sashes.

177. Glass.—Where large-size details are given, there should be no difficulty in finding the sizes of the sheets of glass; but when details are not given, it is often very awkward to know what to take. The following method is, however, quite accurate enough: For casement windows, take the size of the sash and deduct 4 inches both ways; then divide by the number of squares. Any part of an inch is taken as the next inch. For cased frames and sashes, take the size of the frames and sashes over all and deduct 12 inches each way; then divide by the number of squares.

178. Glazing Beads. — Glazing beads or mouldings are measured per foot run. If possible, the size should be given, also whether bradded in or fixed with brass cups and screws. All that are circular should be kept separate, and mitres should always be included.

179. Window Boards or Nosings. — Nosings up to about 3 inches wide should be measured per foot run; window boards over 3 inches wide should be measured per foot superficial. The description should state the thickness and whether rounded or moulded; if tongued to teak or other sill, it must be stated and the groove included; it should also include the bearers. The length is found by taking the width of the inner opening plus sufficient at both ends to bring the window board at least 1 inch beyond the architrave. The width can easily be found up to the edge of the wall, but beyond that it will depend on what size of moulding is under it and the kind of nosing. Take, for instance, where the inner reveal is 9 inches deep; add to this $\frac{3}{4}$ inch for the plaster on wall, and deduct from the result for the total thickness of the cased frame, $6\frac{1}{4}$ inches, which is made up of the inner and outer linings, each 1 inch thick, the sashes each 2 inches thick, and the parting bead $\frac{1}{4}$ inch; or 9 inches $+ \frac{3}{4}$ inch $-$ [(1 inch $\times$ 2) $+$ (2 inches $\times$ 2) $+ \frac{1}{4}$ inch] $= 3\frac{1}{2}$ inches. To find the width of the window board, there should be added to this result for the projection beyond face of plaster plus $\frac{1}{2}$ inch for the tongue into the sill of the frame. Take the fitted ends and the notched, returned, and rounded ends, etc., by number.

180. Mouldings Under Window Boards.—Measure per foot run all mouldings under window boards, giving the size. If tongued to the under side of the window board, it must be so described and the groove included. Take by number the fitted, returned, and mitred ends, etc.

181. Linings.—Window linings up to 3 inches wide should be measured per foot run ; over 3 inches wide, per foot superficial. State the thickness, describe as tongued to frame on one or both edges, including groove, and tongued at angles, also include for backings. The length is found by taking the width plus twice the height of the deduction to form the internal opening, unless anything contrary is shown on detail. To find the width, proceed as for window boards. Panelled linings should be measured per foot superficial, and the number of panels in the set given.

182. Architraves.—Architraves are measured per foot run. The description should state size and whether moulded or chamfered, etc., and should include for the mitres. The length is found by measuring round the outer edge of the architrave ; it will generally be correct to take the length found for the linings or frames and add 4 times the width of the architrave for the gain at the angles.

183. Grounds.—Grounds for architrave are measured per foot run. The size should always be given. Where hidden, the grounds should be described as " framed and splayed." The length may be taken the same as for the architrave ; this, however, is not quite correct, but the difference is generally not considered sufficient reason for making a fresh dimension. Grounds which are not entirely covered by the architrave are measured in the same way, but it is not correct to take the length the same as that of the architrave.

184. Painting.—Since the measurements taken for painting window frames and squares do not include painting on linings, architraves, etc., this must be taken separately as ordinary work per yard superficial.

185. Mouldings.—Where plastered reveals, instead of linings, are specified, a small moulding will usually be required to

hide the junction between plaster and frame. This moulding

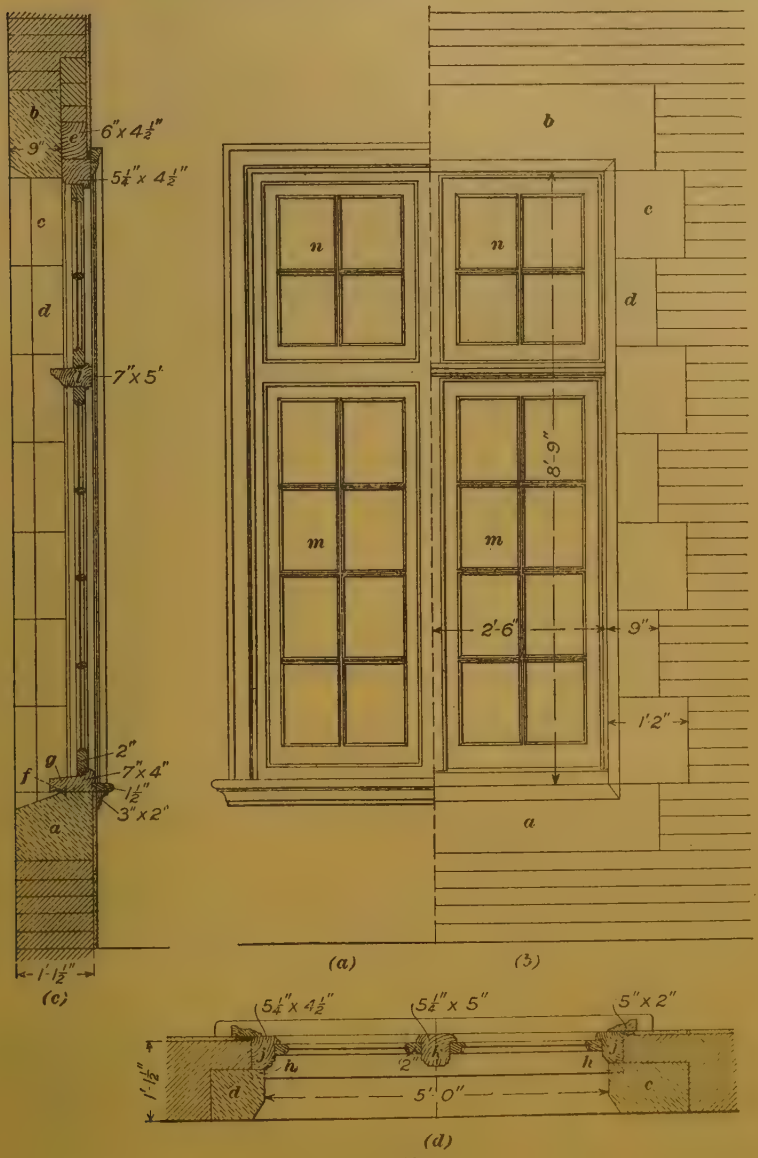


Fig. 29

is measured per foot run; the description should include the

mitres. Similarly measure any mouldings round frame externally; these should be described as "scribed."

EXAMPLE 1.—Take off all the work in connection with the casement window shown in Fig. 29, where (*a*) is a half internal elevation, (*b*) a half external elevation, (*c*) a section, and (*d*) a plan. The stone is Portland, and the joiner's work is all in deal except the sill, which is to be teak. The iron tongue is to be 1 inch by $\frac{1}{4}$ inch.

SOLUTION.—The deduction to form the external opening will be the first dimension; this is the width of 5 ft. by the height of 8 ft. 9 in., both dimensions being in clear of the stonework. This leaves the deduction for each piece of stone to be taken with the stone. The external opening is 9 in. deep, so the deduction will be one brick in thickness. The length of the sill *a* is 5 ft. plus 9 in. each end in wall. The bed is the full thickness of the wall, $13\frac{1}{2}$ in., and the height four courses of brickwork, which equals 12 in. The sill is over 6 ft. long, so must be described as in scantling length. All labours will be included with the cube stone. The deduction of brickwork and facing for the stonework will need no further explanation beyond the item shown on the dimensions for this example. The stone head *b* is the same length as the sill, the bed is 9 in. and the height five courses of brickwork, which is 1 ft. 3 in.

For the jambs, first take the larger stones *c*, which are 1 ft. 2 in. long, 9 in. on bed, and 1 ft. 3 in. high. To each jamb there are four stones of this dimension, so it must be timesed by 4 and again by 2 for the other jamb. The smaller stones *d* are the same as the last, but only 9 in. long; they should be timesed by 3 and then by 2.

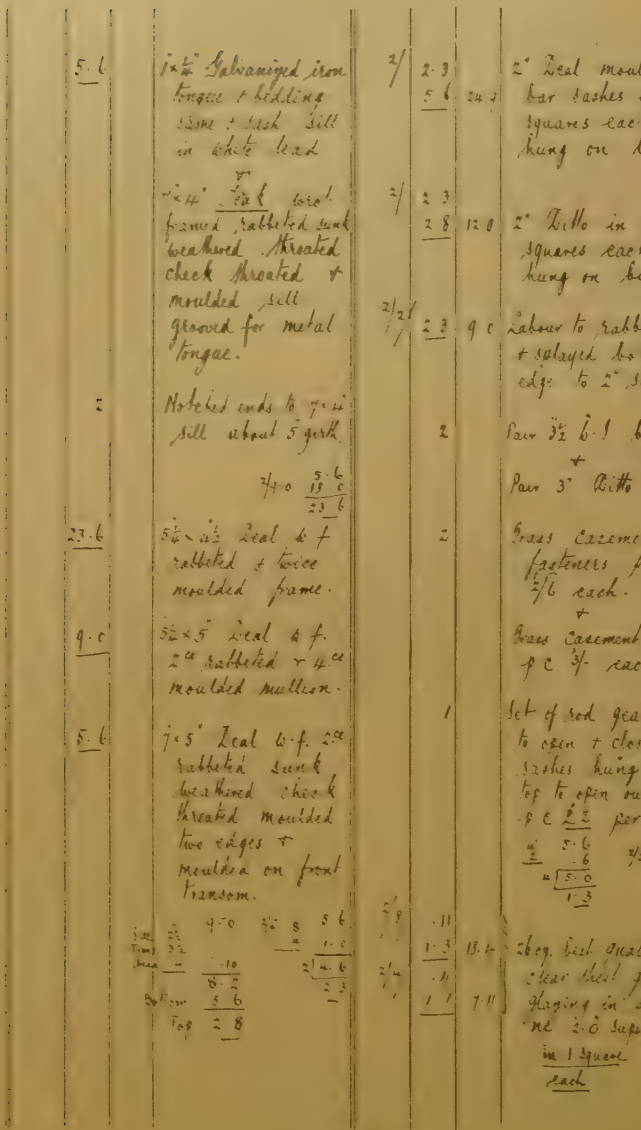
Cutting on facing up to the stone dressings must be measured, as the brickwork and facing have been deducted for the sill; the height will be from the under side of the sill to the top of the head, 8 ft. 9 in. + 1 ft. + 1 ft. 3 in. = 11 ft., which will be multiplied by 2 for both jambs. Five fixing bricks will be required for each jamb for fixing the frame. The frame bedded and pointed will be described as extra large, as it contains over 36 ft. superficial.

The deduction to form the internal opening must now be taken. As the wall is $13\frac{1}{2}$ in. thick, and only 9 in. has been deducted for the external opening, there is $4\frac{1}{2}$ in. or $\frac{1}{2}$ brick left for the internal. The width will be the width of the external opening, namely, 5 ft. plus 3 in. gain at each jamb for the frame and the height 8 ft. 9 in. plus 3 in. gain at the head. The length of the fir lintel *e* is the inner opening 5 ft. 6 in. plus 9 in. at each end; or 5 ft. 6 in. + (9 in. × 2) = 7 ft. The relieving arch is the extreme length of the lintel, has a $4\frac{1}{2}$-in. soffit, and consists of two $\frac{1}{2}$-brick rings. The metal tongue *f* and the teak sill *g* will each be the length of the inner opening. Note that the two grooves required for the tongue will be taken by describing both the stone and the teak sills as grooved. The notched ends to the sill are required because the sill projects beyond the stonework, as at *h*, Fig. 29 (*d*).

Two light basement window.

	5·0		
	8·9	43·9	ddt 1 Bk. in mortar & ddt Red pressed facing a·b.
			2/9" 5·0 1·6 6·6
	6·6		Portland stone and
	1·2		all labour in stop
	1·0	7·7	weathered window sill grooved for metal tongue & in scantling length.
	6·6		ddt 1½ Bk in
	1·0	6·6	mortar. & ddt Red pressed facing
	6 6		P.S. in stop chamfered
	·9		window head in
	1·3	6·1	scantling length.
	6·6		ddt 1 Bk. in
	1·3	8·2	mortar. & ddt Red pressed facing.
2/4	1·2		
	·9		P.S. in chamfered
	1·3	8·9	window jambs.
2/3	·9		
	·9		
	1·3	4·3	
2/4	1·2		
	1·3	11·8	ddt 1 Bk. in mortar
2/3	·9		&
	1·3	5·8	ddt Red pressed facing.
			5·9 1·0 1·3 11·0
2/	11·0	22·0	Cutting on facing up to stone dressings.
	2/5	=10	Extra over ordinary brickwork to breeze Concrete fixing bricks.
	1		G.L. frame & P to stone.
			2/3" 5·0 ·6 5·6
			5·9 1·0
	5·6		ddt ½ Bk. in
	9·0	49·6	mortar & ddt Render float & set walls & 2 Coats distra tint
			2/9 5·6 1·1 7·0
	7·0		
	·6	1·4	Fir lintel.
	1		Extra to rough relieving arch over lintel 7·0 span & 4½ soffit in two half brick rings in cement including all cutting.

FIG. 30 (a)



	5.6		1×¼" Galvanized iron tongue + bedding same + sash sill in white lead	2/	2.3 5.6	24.9	2" Deal moulded bar sashes in 8 squares each hung on butts
			7×4" Teak wrot framed rabbeted sunk weathered throated check throated + moulded sill grooved for metal tongue.	2/	2.3 2.8	12.0	2" Ditto in 4 squares each hung on butts.
				2/2/	2.3	9.0	Labour to rabbeted + splayed bottom edge to 2" sashes.
	2		Notched ends to 7×4" sill about 5 girth.		2		Pair 3½ b.l. butts + bottom
			2/9.0 5.6 / 13.0 / 23.6				Pair 3" Ditto top
	23.6		5¼×4½ Deal w.f. rabbeted + twice moulded frame.		2		Brass casement fasteners p.c. 2/6 each. +
	9.0		5¼×5 Deal w.f. 2ce rabbeted + 4ce moulded mullion.				Brass casement stays p.c. 3/- each.
	5.6		7×5" Deal w.f. 2ce rabbeted sunk weathered check throated moulded two edges + moulded on front transom.		1		Set of rod gearing to open + close two sashes hung at top to open outwards p.c. 2.2 per set.
			9.0 / 2/2 8 / 5.6 / 4 / 1.0 / 2/4.6 / 2.3				4/2 5.6 / .6 / 4/5.0 / 1.3 — 2/2 2.3 / .5 / 2/1.10 / .11
			Sill 2½ / Trans 3½ / Head — .10 / 8.2 / Bottom 5.6 / Top 2.8	2/8	.11 1.3	13.4	26 oz. best quality clear sheet glass + glazing in squares ne 2.0 super. in 1 square each
				2/4	.11 1.1	7.11	2.8 / .6 / 2/2.2 / 1.1

FIG. 30 (b)

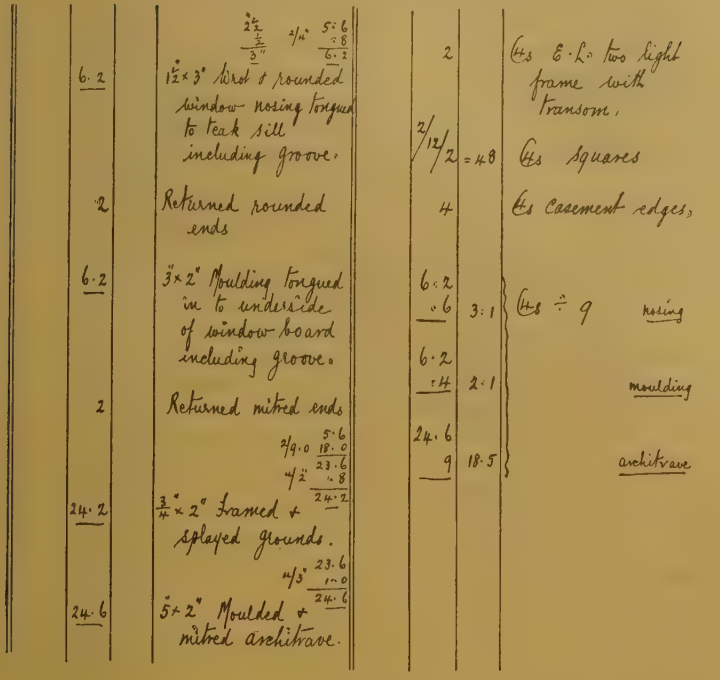


Fig. 30 (*c*)

The frame *j* will be the width plus twice the height of the opening, namely, 5 ft. 6 in. + (9 ft. × 2) = 23 ft. 6 in. The mullion *k* is the height of opening, namely, 9 ft., and the transom *l* the width of opening, which is 5 ft. 6 in.

The sashes must always be taken with care, for very rarely is it safe to scale from the drawings; the width and height must be found from the size of the internal opening. In the present case, take the width first; the opening is 5 ft. 6 in. wide, the frames are $4\frac{1}{2}$ in. wide, but the sash will have to go $\frac{1}{2}$ in. into the rabbet, so that 4 in. only can be deducted for each frame. The mullion is 5 in. wide, and two sashes rabbet into it, so that only 4 in. can be deducted. Therefore (4 in. × 2) + 4 in. = 12 in. must be deducted from the 5 ft. 6 in., leaving 4 ft. 6 in. for the two sashes, so the width of each will be 2 ft. 3 in. Next, the height must be worked in exactly the same way, taking the height of opening 9 ft. and deducting from it $2\frac{1}{2}$ in. for the sill, $3\frac{1}{2}$ in. for the transom, and 4 in. for the head; this leaves 8 ft. 2 in. for the sashes. The bottom sashes *m* are 5 ft. 6 in. high, and the top sashes *n* must be the difference, or 2 ft. 8 in. The bottom edges of the sashes are rabbeted and splayed and the length for each sash will be the width of the sash. The ironmongery will not need any explanation.

Just as the dimensions of the sashes must be found from the size of the opening, so the glass sizes must be found from the size of the sashes. In the present example, the width of sashes is 2 ft. 3 in., the stiles allowing for rabbet being $2\frac{1}{2}$ in. wide; therefore 2 ft. 3 in. $-$ ($2\frac{1}{2}$ in. $\times$ 2) $=$ 1 ft. 10 in. But the sashes are two squares wide, therefore the 1 ft. 10 in. must be divided by 2, which gives 11 in. as the width for each square; the height of the bottom sash is 5 ft. 6 in. minus 4 in. for the bottom rail and 2 in. for the top, or 5 ft. This height is to be divided by 4, giving 1 ft. 3 in. as the height of the squares in the lower sashes; the height for the upper sashes will be found in a similar manner.

For the internal finishings to the window, take first the window nosing, the length of which is the internal opening size 5 ft. 6 in. plus the projection at both ends, or 4 in. The width is 3 in., made up of the projection beyond the teak sill of $2\frac{1}{2}$ in. plus $\frac{1}{2}$ in. for the groove; the moulding under will be the same as last.

A separate measurement had better be taken for the grounds and also for the architrave. Find first the girth of the internal opening, which, of course, is the same measurement as for the frame, namely, the width of 5 ft. 6 in. plus twice the height of 9 ft. $=$ 23 ft. 6 in., then add to this 4 times 2 in., which is the width of the ground, giving 24 ft. 2 in. The length of architrave is found in the same way, except that it projects 3 in. beyond the outside edge of the frame, so that 4 times 3 in. must be added to the length of 23 ft. 6 in.

As the frame contains more than 36 ft. superficial, the painting must be described as on "extra large frame"; as the frame has a mullion, it is termed "two light," and the transom is included in the description. The painting on squares and casement edges needs no explanation. Painting on window nosing, on the moulding under nosing, and on the architrave will be the same length as the respective items supered by a width sufficient to include for all the parts exposed and divided by 9 to bring the dimension to yards super. The edges and extra girths of mouldings have been allowed for in the dimension of the painting; therefore the dimension is divided by 9, and not by 8, as previously stated. The taking off of this example is given in Fig. 30 (*a*), (*b*), and (*c*).

Example 2.—In Fig. 31 is shown a window with cased frames and sashes; (*a*) is a half internal elevation, (*b*) a half external, (*c*) a section, and (*d*) a plan. All work in connection with it must be taken off. The sill is York stone and the joiner's work deal, except the sill, which is in teak. The wall is faced externally with red pressed bricks; the quoins, arch, and apron are to be in Luton brindled bricks. The whole of the grooves and throats that are described in the taking off shown in Fig. 32 (*a*), (*b*), and (*c*) are not shown in Fig. 31, as the scale of the drawing is too small.

Solution.—Only items that were not found in example 1 will be described. The Luton brick quoins are measured as for the facing generally.

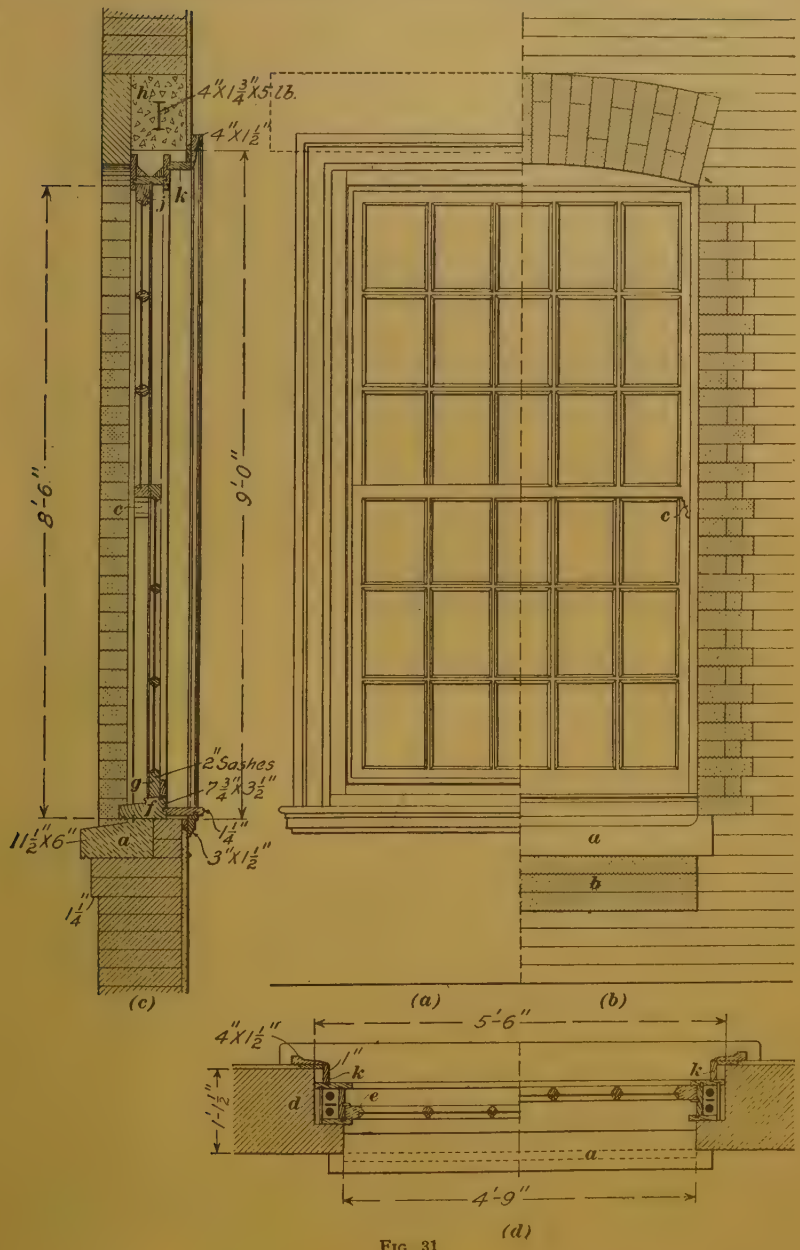

4"X1¾"X5 lb.
4"X1½"
8'-6"
9'-0"
2"Sashes
7¾"X3½"
1¼"
11½"X6"
3"X1½"
1¼"
(c)
(a)
(b)
5'-6"
4"X1½"
1"
1½"
4'-9"
(d)

FIG. 31

That in the reveals is the height by the depth of reveal, which is $4\frac{1}{2}$ in., called 5 in. That exposed on the face must be an average between 9 in. for the stretcher courses and $6\frac{3}{4}$ in. for the other courses, which consist of a header and a closer. The general facing must be deducted for the quoins on the face. The window sill *a* is the length of the external opening, namely, 4 ft. 9 in. plus 3 in. at each end in the wall. The ends are numbered, also the making good of the facing to ends of sill. The apron *b* is the same length as the width of external opening supered by 9 in., or three courses high. The return and pointing to the edge will be the same length as the last plus twice the height; or 4 ft. 9 in. + (9 in. × 2) = 6 ft. 3 in. The length of the concrete lintel *h* and the steel-joist core is the width of the internal opening plus 6 in. at each end in the wall. The dimension for the cased frame and sashes is the same as for the internal opening, namely, 5 ft. 6 in. × 9 ft. Moulded horns *c* are shown to top sash only, so that two will be required.

The measurement of glass will be as follows: The detail shows $6\frac{1}{2}$ in. from the brick reveal *d* to the glass in stile *e* of the sash; therefore, this $6\frac{1}{2}$ in. × 2 must be deducted from the width of opening and divided by the number of squares to arrive at width of each square. The height of each square will be the height of opening minus $6\frac{1}{2}$ in. from the under side of the teak sill *f* to the edge of the glass in the bottom rail *g* minus 8 in. from under side of the concrete lintel *h* to the edge of the glass in the top rail *j*, divided by the number of squares.

The window board and the moulding under will be both the same length, namely, the width of the internal opening plus 3 in. at each end, or 5 ft. 6 in. + (3 in. × 2) = 6 ft. The width of the window board is the inner reveal 9 in. plus $\frac{3}{4}$ in. for plaster minus $6\frac{1}{4}$ in. for the cased frame and sashes, which leaves $3\frac{1}{2}$ in., plus $\frac{1}{2}$ in. for the tongue into sill and 2 in. for the projection of the nosing, making 6 in.

The linings *k* are kept out 1 in. from the brick reveal and 2 in. down from the soffit of the lintel, so that the dimensions of brick opening minus these measurements will form the basis for arriving at the length. The detail shows that the linings finish flush with the wall plastering, so that the width will be taken from the window board minus the nosing, namely, 6 in. − 2 in. = 4 in. The grounds and architrave can both have the same length; that is, the length previously found for the linings, or 23 ft. plus the width of ground multiplied by 4, or 23 ft. + (3 in. × 4) = 24 ft. The dimensions will appear as in Fig. 32 (*a*), (*b*), and (*c*).

DOORS AND BORROWED LIGHTS

186. The deductions of brickwork, etc., also arches, stonework, etc., are very similar to the work for openings, recesses, and windows; such items will not be repeated.

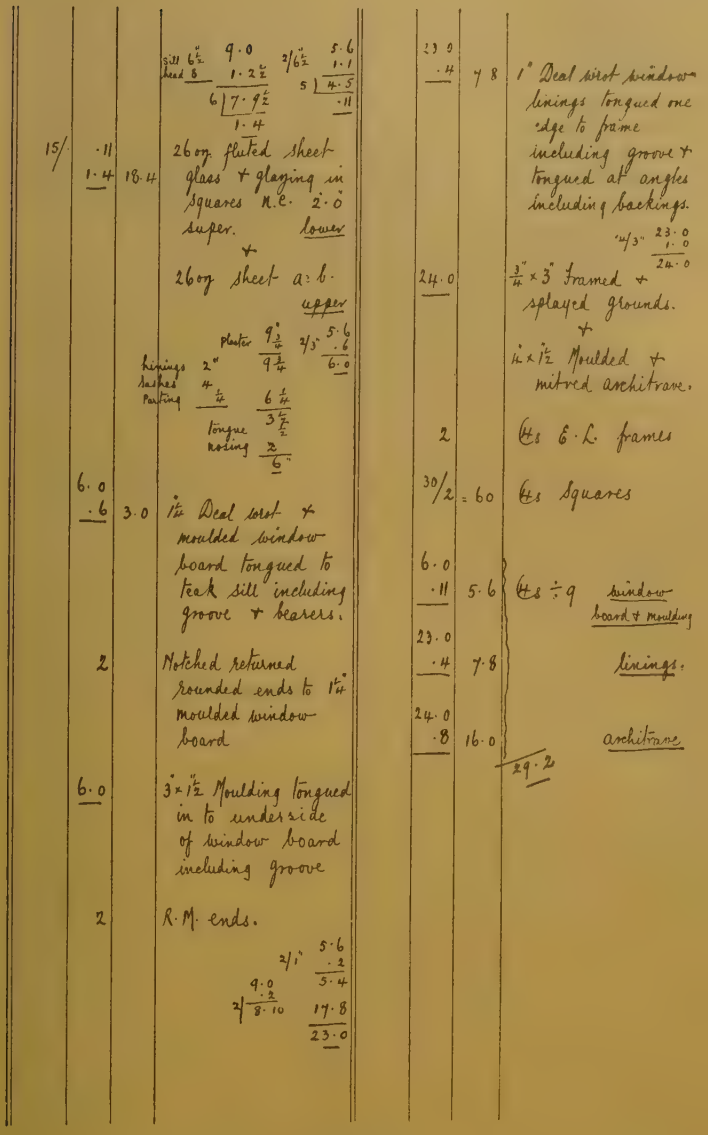
	4.9 8.6	40.5	ddt ½ Bk in mortar + ddt Red pressed facing a. b.
	5.0 .5	2.1	Extra (over ordinary brickwork) to fair axed segmental arches in Luton brindled bricks & pointing to match facing. (Soffit)
	5.3 1.2	6.2	add arch + ddt Red pressed facing a. b.
	4.9		Turning piece to 4½" segmental soffit
2/	1.3	2.6	Fair skewback $\frac{1.2}{13}$ Cutting in red pressed facing
	5.6		Fair Circular Cutting in ditto.
2/	.5 8.6	7.1	Extra (over ordinary brickwork) to facing with Luton brindled bricks to approval in small quantities to quoins and aprons under window sills the joints raked out & pointed at completion with a neat struck weather joint in cement.

2/	.8 8.6	11.4	add facing as last + ddt Red pressed facing a. b.
	5.3		2/3 $\frac{4.9}{.6}$ $\frac{}{5.3}$ 11½ × 6" York stone rubbed sunk weathered & throated window sill grooved for metal tongue
	2		Fair stooled ends including stop to throat. + Make good red pressed facing to ends of window sills.
	4.9 .9	3.7	Luton facing add apron under sill + ddt Red pressed facing + add ⅛ Bk in mortar
	4.9 2/ .9	4.9 1.6	Narrow return and pointing to edges of aprons
	2/5	.10	Extra over ordinary brickwork to breeze Concrete facing bricks.
	1		E. L. frame h & p.

FIG. 32 (a)

					Throated projecting
5 6		Add- 1 Bk. in			sill, grooved for
9 0	14 6	mortar			metal tongue. 2"
		+			deal moulded sashes
		Add- R. T. & Walls			each in 15 squares
		+ 2 coats distemper			with 1½" moulded
		a tint			bars. double hung
		2/6 · 5 6 / 1 0 / 6 6			with best brass axle
					pulleys. flax lines
6 6		Breeze Concrete lintel			+ iron weights. the
		9" on soffit + 12"			bottom bead 2" high
		high composed of			tongued to the teak
		1 part of P C to 5			sill including groove
		parts of Coke breeze			the bottom edges of
		including mould			bottom sashes splayed
		+ hoisting + setting.			+ hollow grooved +
		the steel joist cores			the meeting rails
		are measured			of sashes ½ play
		separately (Brickwork			rabbeted. the head
		has not been deducted)			linings about 5½
					high to clear the
6 6		4 × 1½ × 5 lb. R.S. joist			rear of segmental
		in Cores to Concrete			arches.
		lintels + hoisting +			
		fixing at various		2	Extra to moulded
		levels.			horns to 2" sashes
5 6		¾ × ½" Galvanized iron		1	Brass sash fasteners
		tongue + bedding			p c 1/6
		same + sash sill in			
		white lead		2	Brass sash lifts
					p c 1/- each
5 6		Deal Cased frame			+
9 0	14 6	Consisting of 1" inner			Brass pull down
		+ outer linings. 1½"			handles p c 1/6 each
		pulley stiles + head.			
		back linings. parting		1	Set of handles pulleys
		beads + slips. 7½" ×			+ to open + close
		3½" Teak Sunk			top sashes in Cased
		twice weathered			frames p c 7/6
		throated + check			per set.

FIG. 32 (*b*)



			sill 6½" 9·0 / head 8 1·2½ / 6 | 7·9½ / 1·4 — 2/6½" 5·6 / 1·1 / 5 | 4·5 / ·11
15/	·11 / 1·4	18·4	26 oz. fluted sheet glass & glazing in squares n.e. 2·0" super. lower
			+
			26 oz. sheet a: b. upper
			plaster 9¾" / 9¾ — 2/3" 5·6 / ·6 / 6·0
			linings 2" / sashes 4 / parting ¼ — 6¼ / 3½
			tongue 2 / nosing 2 / 6"
	6·0 / ·6	3·0	1¼" Deal wrot & moulded window board tongued to teak sill including groove & bearers.
	2		Notched returned rounded ends to 1¼" moulded window board
	6·0		3"×1½" Moulding tongued in to underside of window board including groove
	2		R.M. ends.
			2/1" 5·6 / ·2 / 5·4
			9·0 / ·2 / 2 | 8·10 — 17·8 / 23·0

23·0 / ·4	7·8	1" Deal wrot window linings tongued one edge to frame including groove & tongued at angles including backings.
		"4/3" 23·0 / 1·0 / 24·0
24·0		¾"×3" Framed & splayed grounds.
		+
		4"×1½" Moulded & mitred architrave.
2		4s E.L. frames
30/2	= 60	4s Squares
6·0 / ·11	5·6	4s ÷ 9 window board & moulding
23·0 / ·4	7·8	linings.
24·0 / ·8	16·0	architrave
	29·2	

FIG. 32 (c)

187. Steps and Thresholds.—Take off per foot run all steps and thresholds, stating the size and describing all labours on the stone. Allow in the length for ends going into the wall where necessary. Take by number all jointed ends, fair ends, fair rounded ends, etc.

188. Iron Dogs.—The wooden frames to external doors are sometimes fixed to the brickwork by means of iron dogs in lieu of fixing bricks; measure these according to number, giving a full description in each case.

189. Iron Dowels.—Iron dowels are generally specified to be used for fixing the bottom of door frames to the step or floor. Measure these by number and include for the mortises, stating in what material they occur.

190. Doors.—Measure doors per foot superficial. For ledged doors and ledged and braced doors, give the thickness of the ledges and braces, also the thickness and description of the boarding. For framed and ledged doors, and framed, ledged, and braced doors, give the thickness of the door and also the thickness and description of boarding to be used for the filling in. For the foregoing doors, state if the ledges, braces, stiles, or rails are chamfered or stop-chamfered. For panelled doors of every description, give the thickness of door. State in how many panels, and whether square, bead butt, bead flush, moulded, moulded on solid, bolection moulded, moulded with raised and mitred panels, or bolection moulded with raised and mitred panels. Doors that are hung folding or to swing must be separated. Note that for doors hung folding, the width must be increased by the rabbeted meeting stile; 1 inch is usually added for this.

Doors with the upper panels glazed must also be separated. Where the panels are divided into squares, state how many squares in each panel; also state if the upper panels have diminished stiles. Include in the description for the glazing beads or mouldings, stating if fixed with brass cups and screws.

Labours on doors are measured per foot run, stating on what thickness of doors. Doors hung with rising butts will need a splayed top edge. Doors hung folding will need a rabbeted

and beaded meeting stile ; this labour occurs on each leaf of a folding door. For swing doors, the following labours must be taken : " Labour hollow in frame for heel of -inch swing door " ; for the edge of the door working in this hollow the description would be " labour rounded heel to -inch swing door " ; and for the meeting edges " labour rounded edge on -inch swing doors."

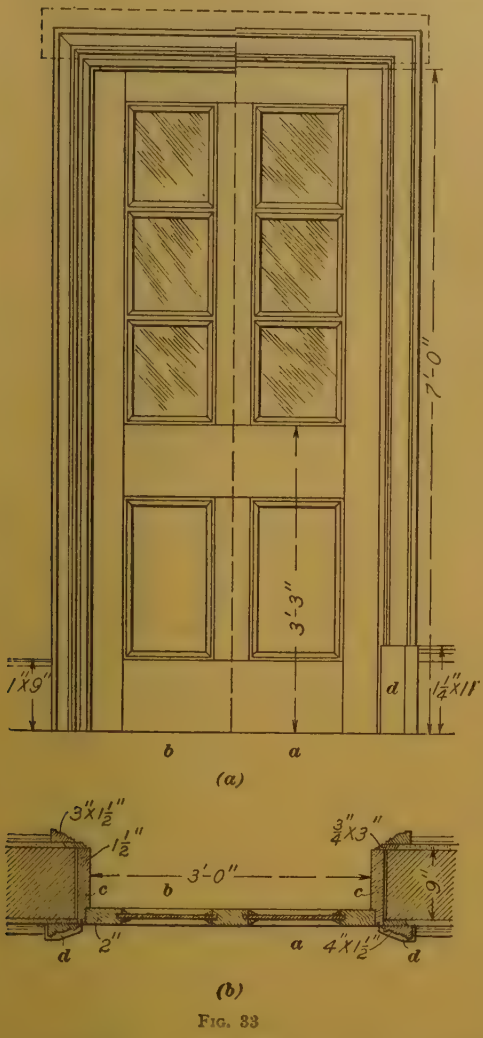


Fig. 33

191. Linings.—Linings to doors where a frame is also used should be measured in the same manner as for windows. Where *jamb linings* are used, that is, the linings that go through the full thickness of the wall and to which the door is hung, measure per foot superficial. Describe the thickness and all labours on same, whether rabbeted, double-rabbeted, beaded, or moulded on one or both edges, etc. Jamb linings are described as " tongued at angles and including backings." Panelled and panelled and moulded linings are measured in the same way, but the number of panels in a set should be stated in the description.

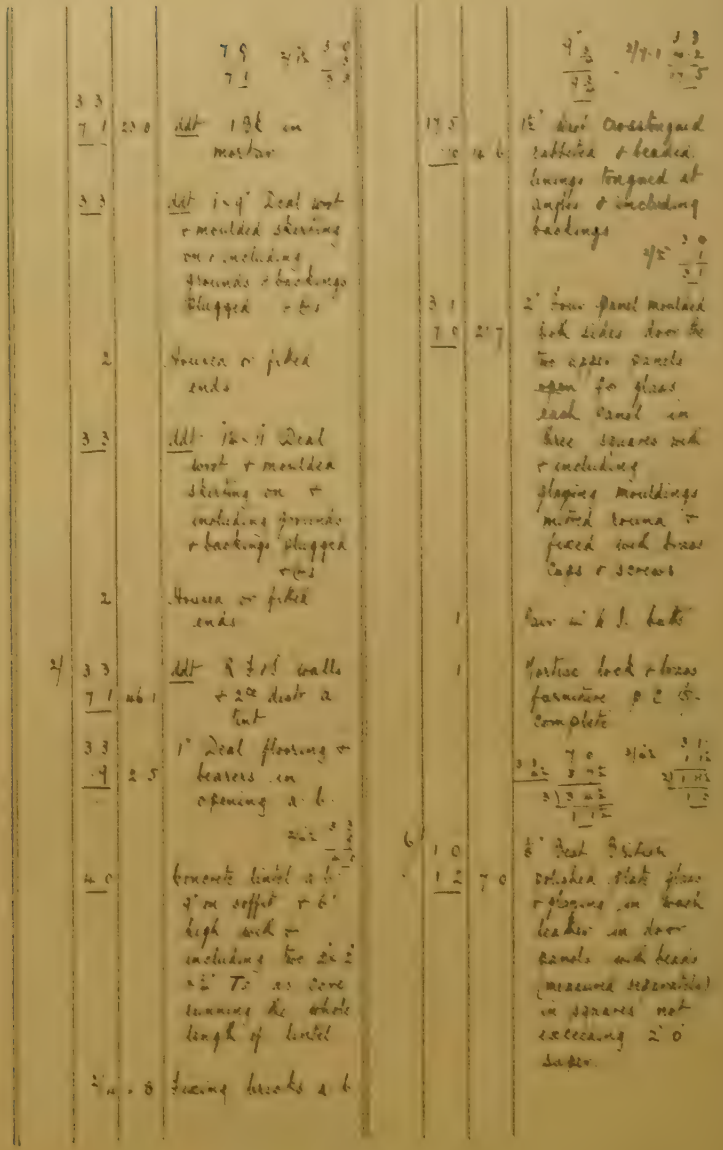


FIG. 31 (a)

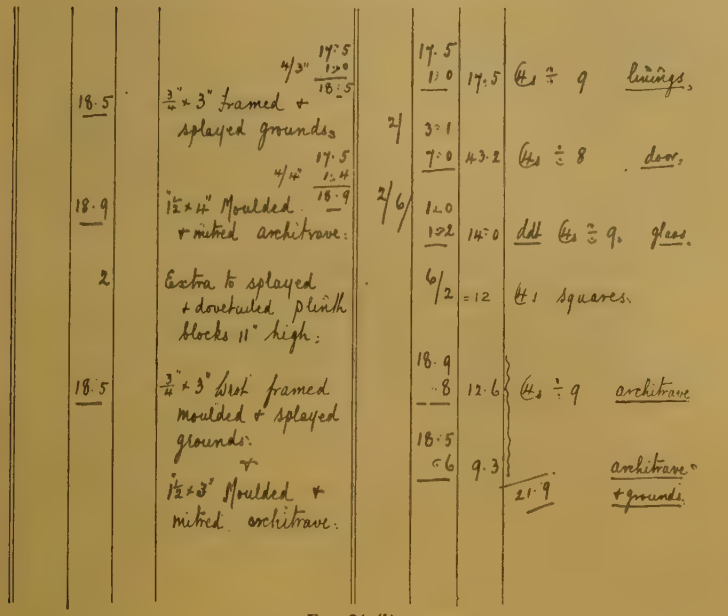


Fig. 34 (*b*)

192. Plinth Blocks. — Plinth blocks at the bottom of the architrave, usually the same height as the skirting, are taken by number as extra over the architrave. Give the size and state whether moulded or splayed and if the architrave is dovetailed and screwed to the base.

193. Painting.—When taking off the painting on doors, a glazed door must have the glass panels deducted from the superficial of paint and the number of squares of painting added in place thereof.

Example.—Take off all the work in connection with the internal door shown in Fig. 33 ; (*a*) is the half elevation of each side and (*b*) is the plan. The flooring on both sides of the opening is 1-inch deal, the concrete lintel is 6 inches high with a $4\frac{1}{2}$-inch bearing in wall at each end and with two $2'' \times 2'' \times \frac{1}{4}''$ steel tees as core. The door is to be hung on one pair of 4-inch wrought-iron butts and fitted with a mortise lock and brass furniture at a prime cost of 15s. complete, and the upper panels of the door are to be glazed with $\frac{1}{8}$-inch best British polished plate glass.

Solution.—The size of openings for doors must always be found either from the size of the door or from the size between the linings. In the

present case, the width is 3 ft. between the linings; so add to this twice the thickness of linings, which makes the width of opening 3 ft. 3 in. The height 7 ft. is for the door; to this 1 in. only must be added for the lining, the other $\frac{1}{2}$ in. of the lining being used for the rabbet. The deduction of skirting and plastering is taken the same as for brickwork deduction, although the skirting is really more on account of the architrave and the plastering is more on account of the grounds, but this fact is usually ignored. Housed or fitted ends to skirting must be taken against the architrave.

The plastering should be deducted for the full height, although there is a wooden skirting. This is done because, when taking wall plastering, it is measured from floor to ceiling and a deduction made from the plastering before billing for the net amount of the skirting.

The width of the linings *c* is the thickness of the wall 9 in. plus $\frac{3}{4}$ in. on side *a* to bring flush with wall plastering. The width is the only thing that need be mentioned with regard to the door; 3 ft. is shown between the linings, but $\frac{1}{2}$ in. at both edges must be added for going into the rabbets of the linings. The glass in the upper panels is found by deducting 3 times $4\frac{1}{2}$ in., for the stiles and muntin, from the width of door and dividing by 2; then deduct from the total height of the door 3 ft. 3 in. up to lock-rail and $4\frac{1}{2}$ in. for the top rail, and divide this result by 3. For the grounds and architrave, first take that on side *a* with the plinth blocks *d* and then that on side *b*. The other work in this example has been previously dealt with. The taking off of the work in this example will appear on the dimension paper as in Fig. 34 (*a*) and (*b*).

STAIRCASES

194. Treads and Risers. — When taking off staircases, the treads and risers are measured per foot superficial; this is found as follows: To the whole length occupied by the treads and risers on the plan add the height from floor to floor and then add 1 inch for each tread with a rounded nosing and $1\frac{1}{2}$ inches where moulded. Multiply this dimension by the width, measured in the clear of the close strings, plus $\frac{3}{4}$ or 1 inch at each end for housing. Of course, where cut strings are used, the measurement of the width must be to the outside of the string.

This is the quickest and best method for a staircase going direct from floor to floor; but where winders form part of the flight, the following method should be used: Divide the whole length occupied by the treads on plan, ignoring the winders, by the number of treads to give the tread; divide the height

from floor to floor by the number of risers both to treads and winders to give the rise. Add the tread and rise together plus 1 inch for treads with rounded nosings and $1\frac{1}{2}$ inches if with moulded nosings. Multiply this girth by the width in the ordinary way, and the result will be the dimension for one complete tread and riser.

It must be remembered that in this second method a riser only must be measured for the top step, as the tread is formed by the floor with a nosing tongued on, which is measured per foot run. This nosing must, of course, be measured to the top step whichever method is used. Describe the thickness of treads and risers, and state whether the treads have rounded or moulded nosings, and also whether with moulding tongued in or planted on under the nosing; also state if glued, blocked, and bracketed, if grooved and tongued together, and, if possible, the size of the carriages. Where staircases are prepared for cut strings, the fact must be so described.

195. Winders and Risers.—Measure all winders and risers per foot superficial. They should be described as ordinary treads and risers, but kept separate as they are cross-tongued and measured net. To find the superficial measurement for the winders, take the area occupied by them on the plan, then collect the length of the risers and multiply this length by the height from tread to tread plus 1 inch for rounded nosing and $1\frac{1}{2}$ inches for moulded nosing.

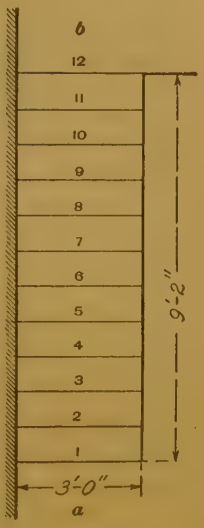


Fig. 35

Example 1.—Take off the treads and risers of the staircase shown in Fig. 35. The floor *b* is 8 feet above the floor *a*; the width shown is in the clear of the close strings; the nosings are rounded.

Solution.—Since the whole length on the plan is 9 ft. 2 in., the height is 8 ft., and the nosings are rounded, the staircase contains

$$[9 \text{ ft. } 2 \text{ in.} + 8 \text{ ft.} + (1 \text{ in.} \times 11)] \times [3 \text{ ft.} + (1 \text{ in.} \times 2)]$$
$$= 57 \text{ ft. } 3 \text{ in. super. Ans.}$$

The taking off will appear on the dimension paper as shown in Fig. 36.

Example 2.—Take off the treads and risers and the winders and risers to the staircase shown in Fig. 37. The floor *b* is 9 feet 4 inches above the floor *a*; the width shown is in the clear of the close strings; the nosings are rounded.

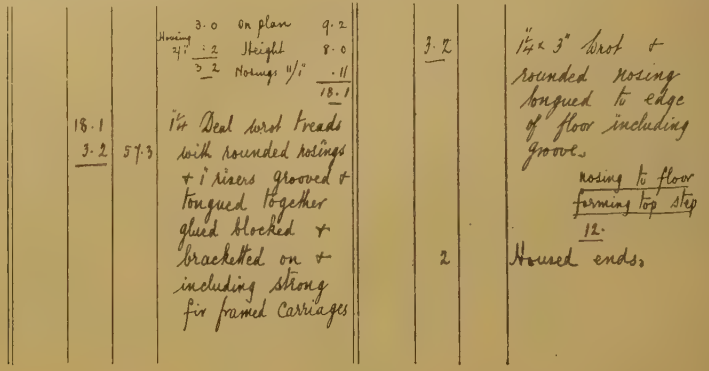

3·0 on plan 9·2
Height 8·0
Nosings 11/1" ·11
18·1
18·1
3·2 57·3
1¼ Deal tarot treads with rounded nosings + 1 risers grooved & tongued together glued blocked & bracketted on & including strong fir framed carriages
3·2
1¼ × 3" tarot & rounded nosing tongued to edge of floor including groove.
nosing to floor forming top step
12.
2
Housed ends.

Fig. 36

Solution.—Since the total length is 5 ft. + 4 ft. 2 in. = 9 ft. 2 in., and there are eleven treads, not counting the winders, the width of tread is 9 ft. 2 in. ÷ 11 = 10 in. The height from floor to floor divided by the number of risers, 16; or 9 ft. 4 in. ÷ 16 = 7-in. rise. As the treads have rounded nosings, the superficial area of one tread and riser is

[3 ft. + (1 in. × 2)] × (10 in. + 7 in. + 1 in.) = 4 ft. 9 in.

The dimensions are entered as shown in Fig. 38.

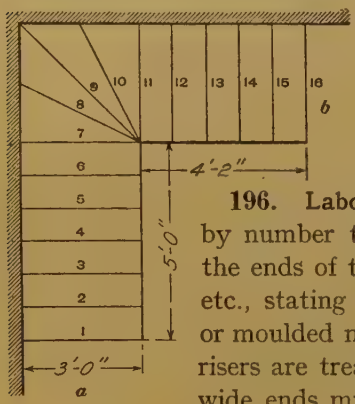


Fig. 37

196. Labours on Treads and Risers.—Take by number the ends of risers that are housed, the ends of treads and risers housed to strings, etc., stating whether the treads have rounded or moulded nosings. Both ends of winders and risers are treated in the same manner, but the wide ends must be separated from the narrow. Nosings of steps returned, moulded, and mitred, or returned and rounded, are only necessary where cut strings are used; when cut brackets are placed under the returned nosings, give the size and describe all labours on same. If curtail ends with blocked and veneered risers are used, give the radius. All notches, etc., in treads to newels must be taken by numbers.

197. Strings.—Measure wall strings per foot run, stating the thickness. Describe the labours and state the method of fixing. Separate strings which are *ramped* or *wreathed;* when 2 feet or over in length or girth they are taken per foot run, but when under this they should be taken by number as "extra for," having already been measured in the length of ordinary string. **Ramped** is the term used for circular or curved work; for

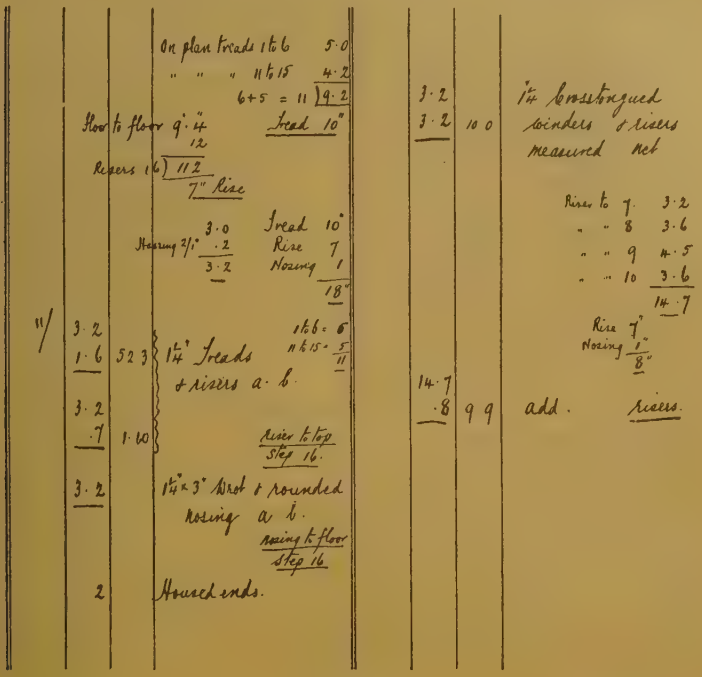


Fig. 38

instance, the string for the winders in Fig. 37. A *short ramp* occurs when leaving the level to go up or down. **Wreathed** is understood to mean circular circular work, that is, work curved to follow stairs and curved on plan; for instance, to a *geometrical staircase*, that is, a staircase with continuous strings without newels. Take by number all heading joints which occur between straight and ramped or wreathed work, fitted ends, tongued-and-mitred angles, and returned mitred ends.

Outer strings are taken per foot run. The thickness should be given and the description should state whether close, or cut and mitred, and the labours on same. Otherwise these are treated as for wall strings. Capping to outer string is either included with the string or is measured separately per foot run. Take by number the ends framed on splay unless the string is described as " framed."

198. Landings.—Take all landings per foot superficial, stating the thickness. They should be described as cross-tongued and usually include the bearers. The nosing is taken per foot run, the same as to top steps.

199. Nosings and Apron Linings.—The nosing to the edge of well holes should be measured the same as the edge of landings, etc. The apron lining should be measured per foot run, giving the thickness and height. Describe all labours on the lining.

200. Newels.—Measure newels per foot run ; give the size and describe all labours on same. They are always described as " framed." Take by number, and describe fully, the turnings to caps and pendants, sinkings to form panels, any newel caps, and also ends stubbed to floor, stating the kind of floor.

201. Balusters.—Number all balusters, giving the size and average length, and describe if turned or other labour. State how they are fixed and whether the top ends are housed to the hardwood hand rail.

202. Hand Rails.—The foot run is used when measuring hand rails. Give the size and state if rounded, moulded, etc., also if grooved for core rail. Separate any portion that is level

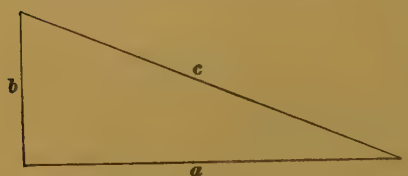


FIG. 39

circular, ramped, wreathed, etc. Take by number ends framed, ends framed on rake, extra for ramps, wreaths, scrolls, etc. All joints in hand rails need hand-rail joint screws ; these should be included in the description ; but for ramps, wreaths, scrolls, etc., they should be taken by number. The length of hand rail can

be found by taking the length of the total girth on plan, setting out at one end a perpendicular line equal to the total rise, and joining the two open ends. This is shown in Fig. 39, where, if *a* is the girth on plan and *b* is the total rise, *c* will be the length of hand rail.

203. Painting.—The painting on staircase work is measured per foot run ; close outer strings need painting on both sides.

204. Plastering.—Plastering to the soffit of stairs and landings is taken per foot superficial. It should be described as ordinary ceiling plastering, but must be kept separate from it. The soffit of winders is termed *flewing* and must be kept separate.

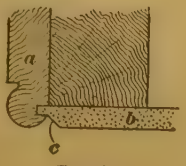


FIG. 40

205. Quirk.—Quirk is a labour in plaster, and is measured per foot run. It occurs generally next the outer string or apron lining. Fig. 40 will explain this, *a* being the outer string or apron lining, *b* the ceiling or soffit, and *c* the quirk.

206. Framing Under Stairs.—The spandrel or other framing under stairs should be measured as described for framings generally. The doors in this kind of framing are best measured by number as extra over the framing, giving the size. A typical description will be "extra over last framing to forming and hanging door in ditto 2 feet 3 inches by 5 feet 6 inches, including all rabbets and beads."

FITTINGS

207. Fittings always vary according to the style of building, so that nothing typical is possible. As they are more costly to make than ordinary joiner's work, they should be taken off with as much detail as possible ; and when there are sufficient to warrant it, all should be kept separate under a heading in the joiner's bill.

208. Cupboards and Shelves.—The cupboard fronts should be measured as for framings and the doors as for other doors ; or else these latter can be measured as extra over the cupboard

fronts. Cupboard ends, divisions, tops, backs, shelves, etc., should be measured per foot superficial, stating the thickness and whether cross-tongued, etc. Include the bearers with the shelves, mentioning whether they are plugged to brickwork or screwed. Take per foot run the ship lap joint in shelves, tongued internal and external angles to fronts, etc.

209. Slate Shelves.—Slate shelves are measured per foot superficial, stating the thickness and whether rubbed on one or both sides. Slabs over 6 feet long or 3 feet wide should be kept separate. Take per foot run the rounded edges, rounded nosings, rabbeted joints and oil cement, also the work of cutting and pinning the edges to brickwork. Take by number any notches, rounded corners, holes, etc., that may occur.

210. Dressers and Plate Racks.—Take by number all dressers and plate racks, giving the length and height, with a full description stating the several scantlings to be used.

SKIRTINGS AND DADOS

211. Skirtings.—When taking off wooden skirtings, measure per foot run. In the description give the size, and state if square, chamfered, beaded, moulded, etc. Where in two pieces, state the size of each. When skirtings are tongued to the floor, so describe, stating to what floor and include for the groove. This latter will, of course, be partly across grain. Include in the description for the grounds and backings, stating whether plugged to wall or fixed to partition, etc. Separate skirtings that are circular on plan. Deduct from the length, found by taking the round of the room, for any fireplaces. Painting is taken per foot run. Take by number all tongued and mitred angles, stating if internal, external, or irregular, also all fitted ends which occur next to chimneypieces.

When taking off cement skirtings, measure per foot run and give the height. State whether it is flush, flush beaded, square, or moulded; for the two latter the thickness should be given. Painting is measured per foot run and mitres and stopped ends are taken by number.

212. Rough Render Behind Skirtings.—The rough render behind wooden skirtings is measured per foot superficial. That on brick is separated from that on lath, which is on stud partitions. The quantity is usually obtained by making a note on the dimensions as follows: "Take the net total length of wooden skirtings supered by 2 inches less height than skirting as rough render behind skirtings," and "deduct render, float, and set walls, or lath, plaster, float, and set partitions." The 2 inches less height is to allow for the ordinary plastering going down behind skirting stopping on top of the first ground.

213. Dados.—The foot superficial is used for measuring wooden dados. The thickness should be given and the work described fully. Generally, the grounds and backings, where necessary, can be included in the description. Take per foot run all labours at angles and also the capping. The latter must have the size given and the labours on same described. Take by number the mitres, and fitted and other ends to the capping. Cement dados are taken off per foot superficial, the thickness being always given. The external angles and the capping are measured per foot run.

214. Picture and Dado Rails.—Picture and dado rails are measured per foot run. The description should give the size and the labours; it should also include the grounds, which must be twice splayed. Painting is measured per foot run and the mitres, etc., are taken by number.

CEILING AND WALL FINISHINGS

215. Plastering.—State the number of coats of plastering, whether render and set; render, float, and set; lath, plaster, and set; or lath, plaster, float, and set, etc. Keep circular work separate from straight, also any work in small quantities. Work finished with gauged stuff must be so described. Plastering of special thickness must be separated and the thickness given. Plaster described as render, float, and set on walls is usually taken as being $\frac{3}{4}$ inch thick, and that described as lath, plaster, float, and set as $\frac{7}{8}$ inch.

216. Distempering, Etc. — Whitening, limewhiting, and distempering are measured per yard superficial on walls and ceilings, but on cornices and mouldings, per foot superficial. The number of coats must always be given. The amount is obtained from the items of plastering and collected on the abstracts. If the plastering is to be clear-coled before distempering, it must be so described.

217. Paper Hanging.—The amount of paper is also usually obtained from the measurement of plastering. Paper, also preparing walls and hanging, is generally valued per piece. A piece of ordinary paper is 36 feet long by 21 inches wide, which equals 63 feet, or 7 yards superficial. An allowance for waste is generally made of 1 yard per piece, so that every 6 yards superficial is called one piece. Therefore, to find the amount or number of pieces required, divide the total feet superficial by 54. Any amount, no matter how small, over one piece must be called the next larger. Papers are rarely selected until the building is ready to receive them, so that a provisional sum per piece is generally included. French papers and ornamental paper, such as Lincrusta Walton, Anaglypta, Japanese, etc., vary considerably in length and width, and are best treated with a provisional sum per yard superficial. Sizing and varnishing on paper should be measured per yard superficial, stating the number of coats of varnish that are required.

218. Ceilings.—All ceilings are measured per yard superficial, but sloping ceilings, ceiling between rafters or in panels, must be kept separate from the ordinary flat ceiling. Work in narrow widths to sides and soffits of beams must also be kept separate.

219. Cornices.—Cornices that have a greater girth than 12 inches are measured per foot superficial; those that have a girth of 12 inches or under are measured per foot run. Where it is on bracketing, the cornices must be described as "on lath." Take by number all external mitres, internal mitres, irregular mitres, stopped ends, returned mitred stopped ends. The bracketing for cornices is taken per foot run, stating for what

girth of cornice. Bracketing is not generally required for cornices under 12 inches girth, but very much depends on the design of the cornice. As a general rule, the plaster should not at any place be very much over 2 inches thick. Take by number each angle and describe "extra for angle blocks to bracketing." Enrichments to cornices are taken per foot run. The girth should be given and the modelling included. Take by number all mitres and stopped ends. Though the ceiling for the projection of cornice at one side and one end is sometimes deducted, unless the cornices are large, at least 18 or 24 inches in girth, this is very rarely done.

220. Centre Flowers.—Measure centre flowers by number, giving the diameter.

221. Fair Face and Point.—Fair face to brickwork and pointing internally to receive limewhite or distempering are measured per yard superficial.

222. Plastering on Walls and Partitions.—Plastering on walls and partitions should be measured per yard superficial. Plastering on patent or concrete partitions should be kept separate, although there may be the same number of coats as on brick walls. Keep separate, also, all plastering on old brick walls, stating that raking out the joints to form the key is to be included. The amount is found by taking the length of the walls or partitions by the height from floor to ceiling, except in the case of cement skirtings; then the height must be measured from the top of the skirting.

223. Angles.—Internal angles in plaster, and the angles between walls and ceilings where there are no cornices, are not measured unless a hollow or cove is required. Then they must be measured per foot run, and described as "extra labour and material forming hollow internal angle, or cove at junction of wall and ceiling plastering, -inch radius, or girth." All labour to arris and any special external angles is taken per foot run.

224. Wall Tiling.—When taking off wall tiling, measure per yard superficial. In the description, give the size, the kind of

tiles to be used, and the method of fixing. If of any special maker, it must be so stated. Include in the description all cutting and waste at internal angles and round openings and also for the necessary cement floated screed to receive the tiles. Any raking or circular cutting and external angle beads must be measured per foot run.

GAS-FITTING

225. More often than not gas-fitting is included in the quantities as a provision and the work adjusted at completion. Whether this is so or not makes very little difference, as all the items that are likely to occur must be put in the quantities, although the amount of each may be only assumed.

226. Pipes.—Gas pipes or tubing are taken off per foot run. The description should give the diameter and include for tees, crosses, elbows, sockets, diminishing sockets, connectors, bends, fire-bends, nipples, short lengths, wall hooks, and fixing; it should also state how joints are to be made. Take per foot run any tarred boxes placed in the ground to receive the pipe coming from the main.

Take by number the work of opening up the ground, footway, etc., for the connection from the building to the main, giving the approximate length, and include for making good after same. Note that all work in the public footway needs watching and lighting, and must be done to the satisfaction of the local authority. Fees must often be paid for doing this work; therefore this should always be stated. Also take an item of connecting the new pipe to the gas main, stating the size of pipe, and include for all joints and paying fees to the gas company, or else paying the company for doing the work.

227. Sundries. — Take by number all stop-cocks, stop-cock pit or box and cover, meter or fixing meter only, shelf for meter, enclosure for meter and connecting pipes to inlet and outlet of meter, including short lengths of pipes. Also take by number, siphons, fittings and fixing, or fixing only fittings, including for blocks in either case. Items must also be taken for holes through

internal walls, floors, partitions, etc., and making good ; screwing down floor boards over gas pipes ; attendance in all trades, giving the number of points ; testing and leaving all satisfactory at completion.

BELLS

228. The crank pull bell is rapidly being superseded by the electric bell. This item is often dealt with by a provisional amount in the quantities, the work being carried out by a specialist. But if the work must be measured, the following items should be taken by number :

1. *Crank-Bells.*—When taking off crank-bells, take the bells, cranks, pulls, and wiring. Describe each and give some idea of the length of wire ; for instance, " to ring from front door to kitchen." Also include bell boards, stating the number of bells.

2. *Electric Bells.*—When taking off electric bells, include the following items : bells, giving the diameter ; batteries, stating the number of cells and kind ; indicators, giving the number of points and style of case ; wiring to each point, stating where to ring from and to ; pushes at a prime-cost sum each, except when only hardwood polished ones are required.

For either kind of bell, items must be taken for holes, screwing down boards, attendance, and testing.

ELECTRIC LIGHTING AND HEATING

229. Electric lighting and heating are generally considered the work of a specialist and are treated as a provisional amount in the quantities. The estimator has to add to this for profit. An item must be taken for attendance on the workmen, including all cutting away and making good ; whenever possible, state the number of points.

SPEAKING TUBES

230. Speaking tubes are more often than not treated as a provisional amount to be paid to a specialist ; if this is not done, the following items must be taken by number : Composition pipe, giving the size and average length, including for all bends ;

lengths of flexible tubing, stating the size and including the brass union and connection to composition pipe ; mouthpieces, whistles, and indicators, describing fully or providing a prime-cost sum, each complete. Items must also be taken for all holes and for attendance.

DRAINS

231. Setting Out.—Before proceeding to take off any drainage work, see that all rain pipes, waste pipes, and sanitary fittings are shown on the plans and connected to the drainage system. Mark, in pencil, the depths of the respective manholes ; this will also give the average depth of digging for the drain pipes.

To find the depths of manholes, work from the top end of the system. The depth below ground of the invert of the drain pipe at this end will, of course, vary, for it will partly depend on whether there is a gully or a water-closet trap connected thereto and also on the style of gully, etc. However, it should be not less than 12 inches below the surface ; and for deep gullies or gullies with raising pieces it may be necessary to go as deep as 24 inches. When this depth is fixed, measure the length to the first manhole ; then from the specification find the fall of the pipes and so obtain the increased depth below the starting point. Add these two depths together and the result will be the depth of the first manhole. Proceed from manhole to manhole in the same way until the whole system is completed ; then see if the sewer is sufficiently deep to allow the pipe from the last manhole to have sufficient fall toward the sewer.

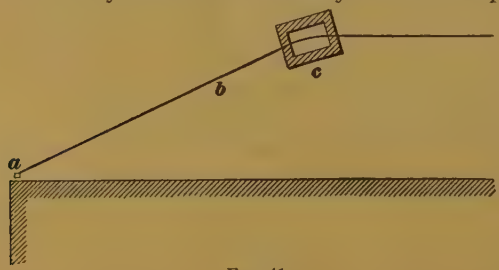


FIG. 41

For example, if the system shown in Fig. 41 starts at *a*, where the pipe is laid 15 inches below the ground, the pipe *b* is 30 feet long and is laid with a fall of 3 inches in 10 feet, the invert, or top, of the concrete bed of the manhole *c* will be 15 inches + 9 inches = 2 feet. The average depth of digging for

the drain pipe b will be $\frac{15 \text{ inches} + 2 \text{ feet}}{2} = 1 \text{ foot } 7\frac{1}{2} \text{ inches}$ plus the thickness of the concrete bed under the pipe.

232. Manholes.—Manholes, cesspools, and rain-water tanks are sometimes taken by number complete. The drawback of this method is that for variation purposes, where sizes and depths vary, there are no rates to adjust on. It is therefore very advisable to measure in detail. The excavation, concrete, brickwork, etc., should be measured in exactly the same way, although kept separate under Drains, as for other work of this nature. Rendering to insides is taken per yard superficial, the thickness being given.

The stone covers are measured per foot superficial. The description should state the thickness and whether tooled or rubbed on top. The rabbeted perforations for the cover are taken by number. Where curbs instead of covers are to be used, they should be measured per foot run, the size being given and all labours described. Iron covers and frames are taken by number; the size, manufacturer's name, and catalogue number should be given or a provisional sum included for each. Describe that the frame is set in cement on brickwork or else to rabbet in stone, as the case may be; also state method of sealing the cover.

Foot irons are taken by number; state the weight or manufacturer's name and catalogue number and include for building into the side of the manhole. Ordinarily, foot-irons would be required for manholes 5 feet deep and deeper; the first one should be placed about 2 feet below the top and another one to every foot of depth.

Channel pipes and bends in the bottom of the manhole should be taken by number. In the description, give the diameter, the length, whether white or salt glazed, and whether half- or three-quarter-round; also include for bedding and jointing in cement in bottom of manhole. Also take by number an item for benching up the bottom of manhole with fine concrete and finishing in neat cement, trowelled smooth, and made good to channel pipes and bends; state the size in the clear of the manhole. Take by number all ends of pipes entering or leaving manholes,

and describe as " making good ends of -inch pipes to 1-brick sides of manholes " ; also state whether cement rendering has to be made good all round.

233. Gullies, Etc.—Gullies, grease traps, rain-water shoes, and intercepting traps must be taken by number. State the manufacturer's name and number in the catalogue, also the size. Include in the description for any grating, digging, concrete bed, and jointing to drain. Take as an extra any back or side inlets, stating for what size of pipe. Take by number any raising pieces, including with same the joint to gully top.

234. Drain Pipes.—Drain pipes, including the digging for same, the concrete bed, and the benching, are generally all measured together per foot run. Describe the size of pipe and whether it is to be from any special manufacturer. If of cast iron, the weight as well as the diameter must be given. In the description state the method of jointing, size and description of concrete bed and benching, and the average depth of digging. Pipes which include for opening up ground in public footway or roadway must be kept separate, for the description must include for watching, lighting, and making good all work disturbed to the satisfaction of local authorities, or else paying them for doing the work. Drain pipes are measured net as laid ; that is, no allowance is made for the portion that goes into the socket, therefore the description should read " measured net as laid."

Take by number all bends, stating to what size pipe and describe as " extra for -inch bends." Note that bends will be required not only when the line of drain on plan changes its direction, but also wherever a pipe is connected to gully, vertical pipe, etc. It will depend on the pattern of the gully, etc., to be used whether one or two bends will be required. Junctions and double junctions must be taken by number and the size given. For instance, " extra to 4-inch junctions," " extra for 4-inch double junctions," " extra for 4-inch on 6-inch junctions," " extra for 6-inch on 9-inch junctions." Also take by number all diminishing, or taper, pieces, giving both sizes ; soakaways, or sumps, stating about the size and depth, also the material

with which the excavation is to be filled. Holes through walls and through foundations or footings for drain pipes must be taken where they occur. State the size of pipe and thickness of wall.

The item for the connection of the new pipe to the sewer must state the size of the new pipe and include for junction or saddle piece and all joints, also for paying fees to the local authorities or paying them for doing the work. Fresh-air inlets must be taken by number; the height and size of vertical pipe given, the joint included with the drain pipe, and the kind of mica-flap valve at top with joint to pipe described; include in the item for fixing. An item must be taken for testing the whole system, including manholes, to the satisfaction of the local authorities and the architect, and for leaving all work perfect on completion.

WATER SUPPLY AND SANITARY FITTINGS

235. Well and Pump.—Well sinking varies considerably, and only the shallow-surface wells would be carried out by the ordinary builder. If one has to be included in quantities, take it by number, giving as full a description as possible. Pumps are taken by number; the prime-cost price is given and the method of fixing. Suction pipe is measured per foot run, the size and weight being given. The connections to the pump and the rose end are taken by number.

236. Cisterns. — Iron cisterns are taken by number. The description should state the size and the thickness or gauge of metal, also the capacity, in gallons. If the shape is unimportant, so that a stock size can be used, it will only be necessary to give the capacity without the size. Iron cisterns are always galvanized, but it must be so stated in the description; also state the height to which the cistern must be hoisted. Wooden cisterns having a lead lining are best measured, where of any size, per foot superficial; if quite small, they can be taken by number. The lead lining also is taken per foot superficial, stating the weight per foot; it is afterwards billed in hundredweights, quarters, and pounds. Soldered angles and copper

nailing are taken per foot run. Allow in the measurement of lead 1 inch for the lap where soldered angles occur. The bearers to the cistern should be measured according to their material. If of wood, they must be taken per foot run ; if steel joists, as described for other joists and the weight per foot given.

Enclosures to cisterns are best measured in detail unless the cisterns are very small. The backings should be taken per foot run ; the boarding and any sawdust packing per foot superficial. Cistern covers and ledges are measured per foot superficial and are either hung to open or made to remove. Sometimes only a portion is hung ; in this case, take this portion, as an " extra only," by number.

237. Water Meters. — Water meters, when required, are usually supplied by the water company. The builder, however, must arrange for the hire of the meter and for joints to the inlet and outlet of the same. The shelf and brackets or pit and cover should be taken by number and a full description given.

238. Feed-Cisterns.—Take by number all feed-cisterns, stating the capacity, in gallons, and include for the cover, ball valve, unions for inlet and outlet, necessary brackets, and fixing complete. All enclosures to feed-cisterns should be taken by number.

239. Lead Safes.—It is often specified that lead safes are to be put under the cisterns, baths, water-closets, draw-offs, etc. The sizes of these vary with the style of fittings and also with the position of the fittings in the room. The safes must be measured in detail: The bottom per foot superficial, the rounded or splayed curb per foot run, and the lead per foot superficial, stating the weight per foot. Copper nailing is taken per foot run; bossed or soldered angles are taken by number and the height given.

240. Lead Pipes, Etc.—All lead pipes, whether as rising main, service, waste, overflow, antisiphonage, flushing, or soil, are measured per foot run. The description should give the diameter and weight per foot or yard run. The weight generally varies according to the purpose for which the pipe is to be

used, so that the different kinds of pipe must be kept separate. The weight of the larger sizes is given by stating the weight per foot superficial of the lead from which they are made. Include in the description for all soldered joints in the length, also for all bends when the pipes do not exceed $1\frac{1}{2}$ inches in diameter. State how the pipes are fixed; whether with wall hooks, plain lead tacks, ornamental cast-lead tacks, lead tacks and astragals, and how far apart these are placed. Also state to what the pipes are fixed, whether ordinary brickwork, external facing, plastered walls, glazed facings, or wall tiling. Pipes that are laid in the ground must include for digging the trench, the depth of which must be given. Lengths under 4 feet of the larger sizes of pipes are best taken by number; if bent, the number of times must be given; and if any joints are included, it must be so stated.

Take by number and state the size of pipe of all extra for bends in lead pipes over $1\frac{1}{2}$ inches in diameter, all soldered, stopped, or dead ends, all soldered joints to unions and fittings, soldered flanged joints of lead pipes to lead safes and cisterns, and beaded, cross-wired, and ornamental cut ends. Branch soldered joints are taken by number and the size of both pipes given; for instance, "$\frac{3}{4}$-inch on 1-inch branch soldered joints."

The opening up of the ground and footway for and the connection of the rising main to the company's main is measured in the manner described for a similar item in gas; the item of connection must include the brass driving ferrule or other brasswork.

241. Wrought-Iron Pipes. — Wrought-iron pipes are sometimes used in place of lead for certain purposes; these are measured per foot run, and in exactly the same way as was described previously for gas. If they are to be galvanized, it must be so stated. Painting the pipes is taken per foot run.

242. Cast-Iron Pipes.—Cast-iron pipes are frequently used as waste, antisiphonage, and soil pipes; they are measured per foot run. State if they are galvanized, and give the diameter, weight per 6 or 9 feet length, and the method of jointing and fixing. Take by number all bends and junctions as extra over

the ordinary pipe, giving the size of pipe ; in the case of junctions, give the sizes of both pipes.

243. Chases and Casings.—Chases in wall for pipes are measured per foot run. The description should state for what size pipe. Pipe casing, where boxed, is taken per foot superficial. State the thickness and include for the rabbeted and beaded grounds, and if it is to be fixed with brass cups and screws it must be so described. The staff beaded or other external angle is measured per foot run. Pipe casing, where covering in to a chase in the wall or in the angle of wall, is taken per foot run, stating width and thickness ; grounds must be included as described for boxed casing. Painting on pipe casings and covering pipes with hair felt are taken per foot run. For the coverings, the size of pipe must be given, and whether it is to be tied with copper wire or twine should be stated.

244. Holes for Pipes.—Holes through external walls for pipes are measured by number. The description must give the size of pipe, the thickness of wall, and what must be made good in the way of facing or plastering on one or both sides. For these holes, pipes not exceeding 2 inches in diameter are generally kept together as small pipes, and those over 2 inches but not exceeding 4 inches in diameter as large pipes. Holes through internal walls, etc., are usually not measured, but an item taken as follows to pay for them : "Allow to cut all holes through internal walls, floors, and partitions, etc., for plumber's pipes and make good after in all trades."

Holes through roof slopes, flats, etc., are measured by number and include any necessary lead slates, sleeve pieces, and joints. A lead pipe coming through a slated or tiled roof slope in the ordinary way will require a lead slate, which must have a soldered flanged joint to the pipe ; but in the case of an iron pipe, a lead sleeve piece and also a lead slate are required. The lead sleeve piece is dressed closely round the pipe and then the lead slate is flange-jointed to the sleeve piece.

245. Stays to Pipes.—Pipes which are carried up above the eaves of the roof or parapets are sometimes specified to have iron

stays. These are taken by number and the item must state what metal is used for the collar and the size of pipe. Describe the stays, whether one or two are required, of what metal, and about the length. Include the eyes and bolts for connecting to the collar and the forged or other ends for fixing to parapet or roof slope, as the case may be. When the ends are fixed to coping, lead plugs, mortises, and screws will be required. When fixed to roof slopes, they should be screwed to the timbers and a lead slate used for making good to the slating or tiling.

246. Connections.—The connections of pipes to drains or to other pipes and the connections of fittings to pipes must be carefully taken. If the following rules are kept in mind, there should not be any difficulty in describing any joint required: They are all measured by number; stoneware to stoneware, such as a water-closet trap connected direct to stoneware drain; stoneware to iron, such as a water-closet trap connected to iron drain; or iron to stoneware, such as an iron soil pipe connected to stoneware drain, will have a cement joint. Lead to lead will have a soldered joint, either branch or flanged. Iron to iron will have a caulked joint in blue lead, or as may be described for jointing of iron pipes. Lead to iron or iron to lead must have a brass or gunmetal thimble or sleeve piece with soldered joint to lead and caulked joint to iron. Lead to stoneware or stoneware to lead must have a thimble or sleeve piece with soldered joint to lead and cement joint to stoneware. Very often lead flushing pipes are connected to flushing rims of closets with india-rubber cone joints tied with copper wire instead of the thimbles, but the thimbles should always be taken for good work.

247. Lead Traps.—Lead traps are taken by number, the size being stated and whether **P** or **S**. The item must state the weight of lead from which they are made, and whether it includes brass screw-cleaning cap and rim soldered in. If it includes any joints at either end, it must state what these joints are.

248. Brass and Other Work.—The following items of brass-work in connection with internal plumbing are measured by number: Standing wastes, giving the size and height and full

description ; brass washers and wastes with fly-nuts and unions and holes in cistern, stating the size and also if including soldered joint to lead pipe ; brass unions with fly-nuts and washers and holes in cistern, stating the size and if including joint to lead or iron pipe ; brass unions for connections between lead and iron pipes, stating the size and if including the joints to the lead and iron pipes ; brass or copper flaps and frames, stating to what size pipe and including for the soldered joint to end of pipe ; brass cobweb or other gratings, stating the diameter and if with cement joint to stoneware sink ; brass grate with plug and rim, stating the size and including for any joint ; gratings, cowls, or hoods at top of ventilating pipes, stating whether galvanized iron or copper and to what size pipe.

249. Valves and Cocks.—Take by number all valves and cocks. For stop-cocks, state the size, whether with unions at one or both ends and whether jointed to lead or iron or both; describe if of any special make and whether brass or gunmetal, and whether screw down and high pressure are required. For bib-cocks, state the size, whether with union or boss and whether jointed to lead or iron ; describe if of any special make and whether brass or gunmetal, and whether screw down and high pressure are required. When bib-cocks are to have loose keys or spanners, or screwed nozzles for hose, they must be kept separate ; also any that are to be labelled " Hot " or " Cold." For ball valves, state the size, which is the diameter of the pipe connected, the diameter of ball, and the material for the ball and rod ; ball valves are generally high-pressure equilibrium ; include in the description for the joint to the rising main, and state whether fixed over top of cistern with clip or to side of cistern. In the latter case, include for hole in cistern and union connection.

250. Sanitary Fittings.—All sanitary fittings are taken by number. In the description state whether the sinks are of stone, glazed stoneware, or fireclay. Give the size inside, or in the clear, and whether brown or white glazed inside and out. Lead-lined wooden sinks are measured the same as cisterns of similar construction. Other sanitary fittings, such as lavatories, baths,

water-closets with water-waste preventers, seats and brackets, and urinals, are best chosen from the catalogue of a specialist or else dealt with as a prime-cost sum ; this latter is the more usual course. Care must be taken that sufficient is included in the price of the lavatories for the taps, plug and chain, and brackets or standards ; in the price of baths, for the taps, waste, and overflow ; in the price of water-closets, if not of the valve pattern, for the seat and brackets, water-waste preventer, pull and chain, and brackets ; in the price of urinals, for the sparge pipes and automatic flushing tank. The estimator must add for profit, packing, carriage, delivery, and fixing complete, including cutting and pinning brackets to walls and all making good.

251. Joiner's Work in Connection With Sanitary Fittings. Draining boards, where not very large, are best taken by number ; otherwise they must be measured in detail, the size and thickness given, and the grooving on top, rounded nosing, bearers, and fixing described. Cupboards and enclosures to spaces under sinks and other fittings are measured in detail the same as ordinary fittings. Bath tops are taken by number, termed *framed*. The thickness, size, and the shaped perforation should be given, also all rounded or other nosing and corners, and the deal-framed cradle under. Framing, as enclosure to bath, is measured as other framing, but is kept separate as dwarf. Skirting round bath top, etc., is taken per foot run ; the thickness, height, and whether plugged or not should be stated. Take by number the fair ends, mitres, etc.

Seats and enclosures, etc., to valve closets should be measured in detail ; the seats and risers, if of the same thickness, can go together per foot superficial, including the deal-framed bearers. If fixed with brass cups and screws, or other method for easy removal, it must be so stated. Flaps and frames are taken per foot superficial. The description should give the thickness and state whether the flaps are mortised and mitre-clamped and whether the frames are beaded or moulded, etc. Take per foot run the rounded or moulded edges or nosing, and the skirting, stating the thickness and height and whether moulded. The mitres and ends to skirting are taken by number, as are

also the holes for pan, which must be cut, shaped, and dished, and the holes for handles, which must be cut and beaded or chamfered.

252. Attendance on Plumber.—Take by number items for attendance on plumber to the several fittings; the description will be "allow to attend upon, cut away for, and make good after, plumber in all trades fixing the following": Under this heading would be given the number of cisterns, stating the capacity, feed-cisterns, sinks, lavatories, stating for how many persons, if more than one, baths, water-closets, and if not valve pattern, including the water-waste preventers, urinals, stating number of persons, and including flushing cistern and draw-offs.

253. Testing.—An item must be taken as follows: "Allow for testing all pipes and fittings to the satisfaction of the architect and local authority and for leaving all work in complete working order at completion."

HOT-WATER SUPPLY

254. Cylinders or Tanks.—Hot-water cylinders and tanks should be taken by number, stating the capacity, in gallons, and the thickness or gauge of metal. Include for bolted man-hole, galvanizing, and for all the requisite unions and back nuts. State for what size of pipes the latter are required and the height to which the cistern must be hoisted. The number of unions required to a cylinder or tank varies according to the system, which should be fully described in the specification. The least number, however, is 4, one each for flow, return, cold-water supply, and expansion or blow-off.

255. Tubing.—The wrought-iron tubing used for flow and return pipes, expansion pipes, and branch service is measured per foot run, as described for wrought-iron water pipes and gas tubing, except that for hot-water work "steam-quality" tubing must be used.

256. Safety Valves.—Safety valves are taken by number. State the size, which will be the diameter of the flow pipe. If from any special maker, it must be so stated.

257. Connections. — Take by number the connections to lavatory and bath valves, including with same any necessary short lengths of lead pipe and all joints and unions. Take an item for drilling the boiler of range and connecting the flow and return pipes, stating the size of pipes.

258. Sundries.—Items must be taken for the following: Attendance in all trades, including holes through internal walls, floors, partitions, etc., and making good, and also for testing the system and leaving in complete working order at completion.

QUANTITIES AND ESTIMATING

(PART 3)

WORKING UP

METHOD OF PROCEDURE

1. Introduction to Working Up.—The stages in the preparation of a bill of quantities known as squaring dimensions, abstracting, casting and reducing, writing bills, and the checking of each stage before the next is proceeded with, are termed **working up,** to distinguish this portion of the work from taking off. The term really means working up in stages the dimensions previously taken off to arrive at the completed bill of quantities. After the work is taken off on to dimension paper, the dimensions are squared by one person, who should at the same time check any wastes made in taking off. The dimensions should then be checked by another.

2. In Fig. 1 is shown a sheet of dimension paper on which the wastes have been checked at the time of squaring the dimensions and ticked in black ink. The dimensions have been squared and entered in the squaring column in black ink, and the dimensions have been checked and ticked in red ink where correct and altered where wrong. The corrections must always be checked and ticked in black ink either at the time the mistakes are found or when abstracting. In Fig. 1, the dotted lines and type figures represent the work that would be done in red ink in the usual course.

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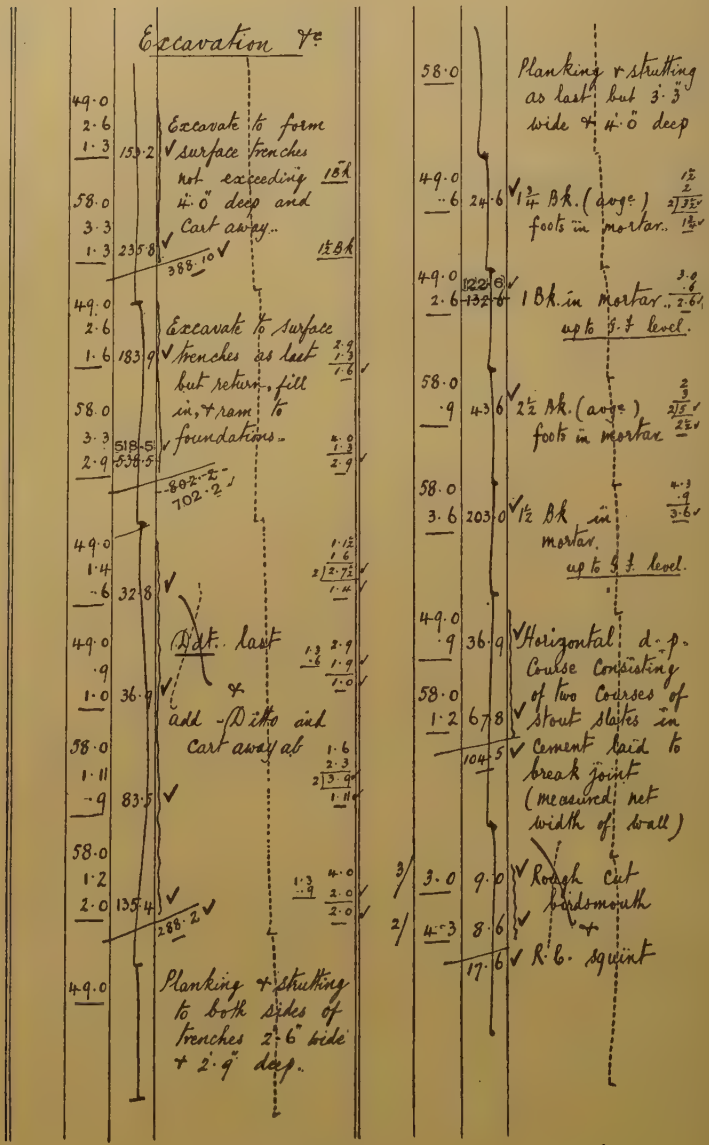
Excavation &c
49·0
2·6
1·3
153·2
Excavate to form surface trenches not exceeding 4'·0" deep and Cart away..
1 Bk
58·0
3·3
1·3
235·8
388·10
1½ Bk
49·0
2·6
1·6
183·9
Excavate to surface trenches as last but return, fill in, & ram to foundations..
2·9
1·3
1·6
58·0
3·3
2·9
518·5
538·5
4·0
1·3
2·9
802·2
702·2
49·0
1·4
·6
32·8
1·1½
1·6
2 2·7½
1·4
49·0
·9
1·0
36·9
Ddt. last
&
add Ditto and Cart away ab
1·3
·6
2·9
1·9
1·0
58·0
1·11
·9
83·5
1·6
2·3
2 3·9
1·11
58·0
1·2
2·0
135·4
288·2
1·3
·9
4·0
2·0
2·0
49·0
Planking & strutting to both sides of trenches 2'·6" wide & 2'·9" deep.
58·0
Planking & strutting as last but 3'·3" wide & 4'·0" deep
49·0
·6
24·6
1¾ Bk. (avge) foots in mortar..
1½
2
2 3½
1¾
49·0
2·6
122·6
132·6
1 Bk. in mortar.. up to G.F. level.
3·0
·6
2·6
58·0
·9
43·6
2½ Bk. (avge) foots in mortar
2
3
2 5
2½
58·0
3·6
203·0
1½ Bk in mortar. up to G.F. level.
4·3
·9
3·6
49·0
·9
36·9
Horizontal d.p. Course Consisting of two Courses of stout slates in Cement laid to break joint (measured net width of wall)
58·0
1·2
67·8
104·5
3/
3·0
9·0
Rough cut birdsmouth
&
2/
4·3
8·6
17·6
R.C. squint

FIG. 1

ABSTRACTING

INTRODUCTORY

3. Explanation of Abstracting.—After the dimensions have been squared and checked, the description of each item with the amount is transferred to *abstract paper* in the order of the trades. **Abstract paper** is double-foolscap size and has a fold in the middle. It is specially ruled on both sides, as shown in Fig. 2. Pages *a* and *b* are both foolscap size, the dotted line *c*

FIG. 2

shows the fold, and the space *d* is for the heading. The abstract is read from top to bottom of the columns and from left to right.

4. Method of Abstracting.—When beginning to abstract, the title of the job should be written in the centre of the proper space *d*, Fig. 2, of a number of sheets. Then the date, giving the month and year, should be placed in the right-hand corner and the title of the trade in the left-hand corner. If more than one abstract is required for a trade, each should be numbered, thus, "Bricklayer 1, Bricklayer 2." The heading is written only on the front of the abstract. The abstracting may

then be proceeded with as follows: If, as occurs in Fig. 1, a description has two or more dimensions, all the dimensions of each description should be added together and the amount placed, when possible, in the description column; this removes the possibility of the figures being added to the next item. Then the description should be written on the abstract paper, a line drawn beneath it, and the amount filled in. When this is done, the item on the dimension paper should be crossed out by drawing a vertical line down the squaring column. An item should never be crossed out on the dimension paper before it has been completely transferred to the abstract paper.

5. The items on the abstracts should be *referenced* by stating from what part of the dimensions the item has been taken. For small jobs it will be sufficient to reference only the first amount of each item, but for larger work it is better to reference each amount. When only one reference is given, it can be put directly after the description in parentheses, but where each amount must be referenced it should be placed at the right-hand side of the amount in smaller figures than the amount itself, so that it will not be taken for part of the amount. It will depend on how the dimension paper has been numbered as to the form the reference will take. If each column or page of the dimension paper has been numbered, the number of such column or page will be sufficient; but where only the sheets have been numbered, the page of that sheet must be given also. For instance, a reference $\frac{18}{3}$ will denote that the item has been taken from sheet 18, page 3. Where more than one person has been engaged in taking off the same job, the initials of the one taking off should precede each reference, though often only the initial of the surname is used; thus, $S\frac{18}{3}$.

6. When more than one description applies to a dimension or set of dimensions, each additional description must be crossed out in the description column by a sloping line. The vertical line in the squaring column denotes that only one description has been abstracted, but it is not drawn until the last description has been transferred. This is shown in Fig. 1, where the dimensions at the end of the second column have two descriptions each.

7. When checking the abstracts, which should always be done with red ink, the adding together of like amounts should be checked, the description on the dimension paper compared with the item on the abstract paper, and then the amounts compared, remembering that both description and amount must be checked. There is a tendency, after having compared a long description, not to pay very much attention to the amount. Any correction necessary must be made in red ink. If the amount is wrong, even only in one figure, the amount should be crossed out and again entered at the end; never make a correction in red ink over black figures. All corrections must have the reference to the dimensions given so that they may be verified or rechecked before the abstracts are prepared for billing. If the item is correct, a neat red-ink tick should be put against the item on the abstract and the item cut out on the dimensions by drawing a vertical line in red ink down the description column, see Fig. 1. An item should never be cut out on the dimension paper before it is ticked on the abstract.

8. **Important Points in Abstracting.**—In abstracting, the following points should be observed, as they are very important:

1. Trade by trade should not be abstracted unless compulsory. The beginning of the dimensions should be started first and proceeded with, item by item, irrespective of the different trades. By this means the taking off can be followed at the same time and any slight mistake will quite probably be noticed.

2. Plenty of paper should be used in abstracting. Crowded abstracts are very dangerous, as items run into each other and get confused. Moreover, time is wasted in finding any particular item, and the billing of a crowded abstract becomes very laborious and tedious.

3. All figures should be made as plain as possible. Bad 1's, 7's, 9's, 3's, and 5's, which may easily be taken for figures other than what are intended, should be specially avoided.

4. All figures should be kept under one another. If this is not done, serious mistakes may be made when adding up the figures. For a long list of figures, it may be useful to draw

lightly in pencil vertical lines, so as to form columns for inches, units, tens, hundreds, etc. A comma should be placed between the hundreds and the thousands, as this is a great aid in adding up the figures.

5. Where deductions are necessary on the abstracts, care must be taken to make it very clear from which item the deduction must be made.

6. As far as possible, not only in abstracting, but also in billing, the too frequent use of the word *ditto* should be avoided.

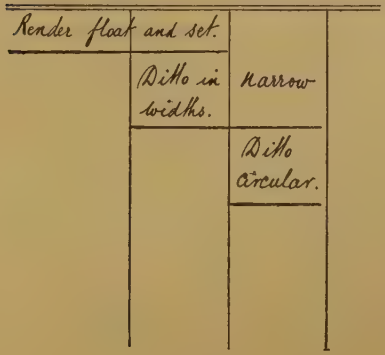

FIG. 3

This method of saving writing and time should be used only in cases when there cannot be the slightest doubt as to how much of the previous description is meant to be covered by the ditto. An example of this ambiguity is shown in Fig. 3. As written, the last item will read "render, float, and set circular." Should it be intended to read "render, float, and set in narrow widths circular," another ditto should be used, the first one covering the "render, float, and set" and the second covering the "in narrow widths." In such cases as this it is better to use only the one ditto and write "in narrow widths circular."

ORDER OF ABSTRACTS

9. List and Order of Trades.—The list of trades in the order in which they would be kept both for abstracting and billing is as follows: Preliminaries, etc.; excavator and concretor; bricklayer; drains; waller; mason and terra-cotta; slater and slate mason; tiler; carpenter; joiner and ironmonger; founder and smith, gas-fitter, bellhanger, electric bells, electric light, heating, and speaking tubes; plasterer; external plumber, zinc worker, coppersmith, internal plumber, and hot-water fitter; glazier; painter; paperhanger.

10. General Order of Items.—The general order of items in each trade, though it must not be taken as a hard-and-fast rule, as there are many exceptions, is as follows: Cubic dimensions, superficial dimensions, running or linear dimensions, numbers. Items of labour only generally precede those which include labour and material. Items of extra labour, whether per foot run or per number, which are in connection with items which have been measured per foot superficial, are put with other items per foot run or per number. But items of extra labour which are in connection with items that have been measured per foot run should follow immediately after the item; this is termed *writing short;* for instance, mitres on a running length of wood moulding should follow the moulding, and are then said to be *written short.*

ORDER OF ITEMS IN DIFFERENT TRADES

11. Preliminaries, Etc.—For general work, there are usually very few items in the way of preliminaries that must be put on the abstracts. Preliminaries are mostly written direct to the bill from the specification, so it will generally be sufficient to leave the first few columns of the excavator's abstract for any items that may be found on the dimension paper; for instance, the provision for contingencies, items of special scaffolding, hoarding, screens, temporary roofs, floors, difficult access, work to street pavement, or to adjoining premises. Of course, where the work is in connection with an existing building, much more room must be left on the abstracts for items of alterations to and in connection with existing work.

12. Excavator and Concretor.—The items on the abstract for excavator and concretor should be put in the following order: Excavation over surface, the superficial items coming before the cubic; excavation to basement; excavation to trenches below basement; excavation to surface trenches; and excavation in underpinning. In each case, return, fill in, and ram should come before the cart away. Excavation would be followed by planking and strutting, that for excavation being put before that for trenches. Broken stone or brick would follow, the cubic

item coming first, followed by superficial items, according to the thickness, and then the filling to fender walls. Concrete work is then taken, ballast concrete being kept separate from breeze concrete ; the cubic items should always be taken before the superficial. All concrete made with lime must be taken before that made with cement, while ordinary foundation concrete is taken before pier holes, grillage bases, and underpinning. These are followed by layers of concrete over surfaces, according to thickness, the levelling up of trimmer arches, and the filling in to fender walls.

When abstracting breeze concrete, all floors are taken before any flats and both are kept according to thickness and then according to height from the ground level. The following work is then taken in order : Extra to forming channels or gutters, casing down to form beams, extra to forming cesspools and sundry items of extra labour.

Concrete partitions, lintels with cores measured separately, lintels that include the cores, and staircases with all items in connection, should be kept under separate headings. Concrete fixing bricks are usually kept at the end of all other concrete work.

13. Bricklayer.—The first items on the bricklayer's abstract will be the brickwork itself, which before billing must be reduced to rods or yards. These items of brickwork need plenty of room ; on no account should they become cramped on the abstract. All items from the dimension paper are entered on the abstracts under one of the three headings : 1 brick, $1\frac{1}{2}$ bricks, and cube. After each of these headings a column should be left for the deductions from each. All superficial items of brickwork must be reduced to 1-brick or $1\frac{1}{2}$-brick measurements, preferably the latter. The amount of $\frac{1}{2}$ brick, whenever possible, should be divided by 3 and the result placed in the $1\frac{1}{2}$-brick column ; in cases where the amount is not divisible by 3, it should be divided by 2 and the result placed in the 1-brick column. The amount of $\frac{3}{4}$ brick should be divided by 2 and the result placed in the $1\frac{1}{2}$-brick column ; the amount of 2 bricks should be multiplied by 2 and the product placed in the 1-brick

column. The amount of $2\frac{1}{4}$ bricks is placed in the $1\frac{1}{2}$-brick column and one-half the amount then added. The amount of $2\frac{1}{2}$ bricks is placed in both the 1-brick and the $1\frac{1}{2}$-brick columns.

14. The order of the reduced brickwork should be as follows: Take the cheapest, sometimes termed *common*, or *ordinary*, brickwork first, then follow with brickwork over 60 feet above ground, brickwork in backing to masonry, brickwork in raising on old, brickwork in filling into openings, brickwork circular on plan, and any brickwork in underpinning. Extra only for brickwork being in cement will then follow with $\frac{1}{2}$-brick walls, $\frac{1}{2}$-brick sleeper walls, $\frac{1}{2}$-brick trimmer arches, special 1-brick walls, thicknessing to old work, hollow walls, and brick-nogged partitions. The other superficial items are taken in the following order: Rough cutting, extra to battering face, extra to fair face, extra to fair arches, twice limewhiting, coating steelwork with cement wash, slate horizontal damp-proof course, slate vertical damp-proof course, the patent partitions, and any extra-labour items on the latter.

15. Running or linear items are likely to vary considerably, but the following will be about the right order in which they should be abstracted: Rough-cut birdsmouth or squint; rough-cut chamfer; fair skew-back cuttings; circular fair cuttings over arches; fair bullnose angles; beam filling; chases for floors and flats; levelling and preparing walls for raising on; chases for partitions, pipes, etc.; cutting, toothing, and bonding new work to old; cutting and pinning edges of landings, shelves, etc.; needling and shoring up walls while underpinning; grubbing up and removing for underpinning; wedging and pinning up between new and old work in underpinning; raking out joints, wedging, and pointing flashings; cement weathering to offsets; and hoop-iron bond.

16. Number items very often need a great deal of room on account of the ends cut and pinned and holes through walls, etc., having so many different kinds of facing, etc., that must be made good. The order of number items should be: Ends built in or cut and pinned, rough relieving arches over fireplaces,

rough relieving arches over lintels, rough segmental arches over openings. The holes through walls should be divided into three divisions: whether for large or for small pipes, the facings that must be made good, the thicknesses of the walls. Fair outlet holes through parapets, etc., should come after all other holes. Then should follow the items of levelling up bases of columns or stanchions, bedding and pointing frames, rendering chimney backs, rendering over ranges, flues parge and core, chimney pots, the setting only of stoves, the setting only of ranges, fixing only of chimneypieces, and coppers including the setting of same. Such items of ironwork as are usually abstracted with the bricklayer will come last; namely, soot doors and frames, air bricks, and ventilating gratings.

17. Facings are usually kept quite distinct from the other bricklayer's work, and each kind of facing brick with its arches and labours is under a separate heading. These facings are arranged in the order of cost, the cheapest being placed first. For instance, picked stocks will come before red bricks, and blue and glazed bricks will follow red. The order for each particular kind of facing is first the facing and pointing and then any that is in small quantities. The items of arches follow the facing, first the straight, then the segmental and semicircular. In each case the first item of work taken per foot run is fair skew-back cutting, then follow fair circular cutting, fair cut squint or birdsmouth, cutting up to stone dressings, narrow returns and pointing to aprons, extra to oversailing courses, bullnose angles, splayed courses as plinths, moulded or other courses as strings, cornices, etc. Copings are best put at the end of the runs, as on account of the tile creasing, etc., material as well as labour is included. Such number items as making good to window sills are placed last.

18. Pavings are abstracted according to their value, generally the cheapest first; the order should be: Granolithic, tile, terrazzo, mosaic, etc. Cuttings on tile paving and sundry notchings and making good in connection with tile and other pavings follow the respective kinds of paving. Asphalt should be kept under a separate heading; a good order is horizontal damp-proof course, vertical

damp-proof course, paving, flats according to height above the ground level, angle fillets, dressing to channels or gutters, etc., and skirtings. All number items should be placed at the end, such as lining outlets through walls, lining cesspools, etc.

19. Drains.—On the abstract, the main divisions for drains will be stoneware drain pipes, cast-iron drain pipes, and manholes. The first items taken are the pipes, with the digging and concrete; these are taken according to the size of the pipe, beginning with the smallest diameter, and then according to the depth of the digging. Next are taken the bends, junctions, diminishing junctions, diminishing or taper pipes, ends of iron pipes connected to drain, water-closet traps connected to drain, connections to sewer, rain-water shoes, gullies, back or side inlets to gullies, raising pieces, grease traps, intercepting traps, and any soakaways or sumps.

Manholes should be kept under a heading, a list being made of how many there are. The order of items is excavation, concrete, benching up bottoms, brickwork, making good ends of pipes to sides of manholes, rendering, channel pipes and bends, stone covers, stone curbs, perforations for iron covers, foot-irons, and iron covers; after the manholes fresh-air inlets should be put complete and the item of testing drains.

20. Waller.—The general outline order on the abstracts for waller is foundations, walling, levelling up, internal angles, facings, and dressings.

21. Mason and Terra-Cotta.—The abstracts for the mason will need careful setting out, especially if the stone dressings are elaborate; the stone used for dressings will always come before that used for general purposes, such as steps, ordinary window sills, etc. Where more than one kind of stone is used for dressings, each kind should be kept separate, the cheaper being placed first.

When the stone for dressings is measured to include all labours, the several items should be kept under separate headings, as follows: Ashlar and bands; plinths; strings; cornices; copings; window and door dressings in the order of sills, jambs,

mullions, transoms, heads, lintels, arches, etc.; pilasters; niches; and chimney stacks. Under each of these headings, the stone with the least amount of labour, and therefore the cheapest, should come first.

22. Where all the labours on stone dressings are measured separately, the order of abstracting is: Cube stone, half sawing, rough sunk, beds and joints, sunk beds and joints, circular beds and joints, circular sunk joints, plain face, circular face, circular circular face, sunk face, sunk face circular, sunk face circular circular, moulded work, moulded work circular, moulded work circular and continuous; the running items of throat, mitres to splay, chamfer, groove, plain margins, sunk margins, rabbets and mouldings; the number items of stops, mitres, etc., to weatherings and sinkings, and stops, mitres, etc., to mouldings. All stops, mitres, etc., are averaged on the abstract paper, so that each kind must have the width of a whole column. This is shown in Fig. 4, the first item of which means ten mitres to a moulding of 7 inches girth, which has been taken from sheet 9, page 2, of the dimension paper.

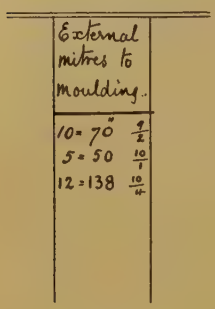

FIG. 4

23. Whether the stone has been measured to include all labours or whether the labours have been measured separately, the foregoing items will be followed by such sundry items as extra hoisting, extra for setting stone in cement, sundry items of groove, rabbet, perforations, notchings, mortises, dowels, cramps, etc. At the end of the stone dressings, the items for boasting for and carving to the several features should be kept. Granite will follow after all other stone dressings, the order being practically the same.

Stone for general purposes, whether York or other stone, should be kept in the following order: Cover stones, pavings, hearths, tops to coal shoots, and sloping bottoms to coal shoots, all according to thickness. The running items are tooled edges, rubbed edges, grooves, rabbets, curbs, steps and thresholds, window sills, and copings. The number items are mortises for

ironwork, perforations, notchings, rough corbels, templates, base stones, cramps, dowels, etc.

Staircases are placed under a separate heading, the items being kept in the following order: Landings, rubbed and other edges, jogglejoints, rabbets, rounded and other nosings, steps, winders, mortises, and patent treads.

Terra-cotta is generally placed after all the mason's work. If measured in detail, the order is: Plain work, moulded work, enriched work, extra hoisting, cleaning off reveals, cleaning up and straightening grooves, cramps, dowels, etc.

24. Slater and Slate Mason.—When abstracting, the order of items for the slater's work is: Roof slating, cutting and waste to top edge and abutments, circular cutting and waste, cutting and waste to sides of valleys and hips, extra to eaves, extra to verges, slate ridges, and slate hips. The slate mason's items should be taken in the following order: Superficial items of slate according to thickness, rounded edges and nosings, rabbeted joint and oil cement, notches, rounded corners, perforations, etc.

25. Tiler.—In all cases the order of tiler's work will be very similar to that for slater; the order in which to abstract is: Roof tiling, cutting and waste to top edge and abutments, circular cutting and waste, cutting and waste to sides of valleys and hips, cut and mitred hips, extra to eaves, extra to verges, hip and valley tiles, ridge tiles, and terminals. Vertical tile hanging should be placed after all roof work; the items likely to occur are tile hanging, cutting and waste to sides and bottom of openings, raking cutting and waste, extra to eaves course, extra to internal angle tiles, and extra to external angle tiles.

26. Carpenter.—The space required on the abstract paper for setting out the carpenter's work will depend entirely on the nature of the work. Domestic buildings will require very much more space than a factory where concrete is to be used for floors, flats, etc.; for the latter building, more space will be required for centring. Custom varies as to the order at the beginning of the carpenter's abstract; the order suggested is one that is

greatly used and is recommended because the centring comes first. Centring is always of a temporary nature, and is sometimes called *use and waste;* therefore it is consistent to put such items before the more expensive cubic items.

Centring should be kept in the following order: Flat-boarded centring to floors and flats; raking and circular cutting and waste; temporary boarding for vertical sides and edges of concrete; centring for arches and soffits, that for straight arches coming before that for segmental and semicircular; centring for trimmer arches; running items of turning pieces for straight and segmental soffits; centring for semicircular soffits; number items of notches for keystones, and centres to bullseyes and pointed arches.

27. After centring should come the items of bracketing to sides of steel joists, etc., to form beams and bracketing for plaster-moulded cornices. Cubic items of fir should come next. Fir in wall plates and lintels, then in ground joists and sleepers, should be followed with framed work in floors, roofs, partitions, studding to dormers, etc., and roof trusses. Any work that is described as "wrought and framed" should then follow in the foregoing order. The superficial item of labour planing or wrought face on fir should be placed at the end of the cube measurements.

Under the heading of deal should follow the superficial items in the following order: Battens for slates and tiles, roof boarding, boarding to flats, boarding to dormer cheeks and tops, gutter boards and bearers, snow boards, sound boarding fillets and pugging, ridges, and hips. Labours on fir and boarding should be placed at the beginning of the running items with plugging walls, feather-edged springers, herringbone strutting, and tilting fillets following. Other items of running dimensions should be placed in the order of the thickness and then of the width.

Number items should commence with those of labour only; then should come fixing fillets, bridging pieces, gusset ends to gutters, short rolls and drips, cesspools, purlin cleats, sprockets, scarfed joints, and coach screws. Felt to roofs and felt seatings should be placed at the end. The half-timber work should be

kept under a separate heading, taking the smallest scantlings first. Fencing and gates should come last.

28. Joiner.—The first heading on the joiner's abstract is floors. This division should begin with counter floor, if any, then should follow boarded floors, which should be arranged first according to material, deal coming before oak, then according to thickness, and finally according to the amount of labour. Wood-block floors should then follow and parquet floors should be placed at the end. All labours on floors should follow the particular items of floor with which they are concerned. The next main division is skirtings; these should be arranged first according to the material, then according to the thickness, the height, and the amount of labour.

29. When abstracting windows, doors, thicknesses, etc., the various kinds of wood are kept quite separate. Any work not in deal is abstracted after the number items in deal, and not kept under the respective headings, as is done with floors and skirtings. The order of abstracting windows in deal is as follows: Sashes according to thickness, those fixed coming before those hung and those in one square before those in two or more squares. Skylights usually follow after sashes, as the construction is very similar. Cased frames and sashes come at the end with moulded horns following, according to the thickness of the sashes.

30. On the joiner's abstract, doors and framings in deal follow the windows; all doors come before any framings. The order in which the doors should be arranged is: first according to thickness, then those that are ledged, ledged and braced, framed and ledged, and framed, ledged, and braced. After these should come panelled doors, according to the number of panels and labour on same. Solid doors should precede those that have glazed upper panels, and the latter should be followed by all special doors such as are hung to swing, hung folding, and circular-headed doors. Framings should be taken according to their thickness and the labour on same. Items of "extra to forming and hanging doors" should follow the respective descriptions of framing.

Other superficial items are abstracted under the heading of thicknesses in deal and should be arranged strictly in the order of thickness, that of least thickness of course coming first. After being arranged by thickness, they should be taken according to the amount of labour on each item. It is usual to keep at the beginning of each thickness any items that may be priced per square instead of per foot; for instance, the many kinds of boarding.

31. The running items in deal are likely to be very numerous for domestic work. Commence with all items of labour only and then follow strictly in accordance with the scantlings, the smallest scantlings coming first. Under each scantling arrange the items according to the amount of labour. Always enter first on the abstract paper the smaller of the two sizes given for running dimensions, as this size will be the guide for the order on the abstract; for instance, three running items, irrespective of their labours, $4\frac{1}{2}'' \times 4''$, $2\frac{1}{2}'' \times 3''$, and $3'' \times 5''$, would be entered on the abstract in the order of $2\frac{1}{2}'' \times 3''$, $3'' \times 5''$, and $4'' \times 4\frac{1}{2}''$. Mouldings in deal will follow the other running items and should be abstracted according to scantlings, as last described. Plinth blocks should follow the respective items of architrave.

The number items would commence with those of labour only, such as notched returned ends to window boards, etc. They are followed with shelves for meters, copper lids, ladders, plate racks, and dressers. At the end of the ordinary numbered items are placed the attendance on plumber fixing sinks, urinals, water-closets, lavatories, baths, feed-cisterns, and cisterns.

32. After all the joiner's work in deal should be abstracted that in oak, teak, mahogany, and other hardwoods under their different headings. The order of abstracting is exactly the same as that given for deal. Staircases follow, and all the work in deal comes before any in hardwood. The general order for each kind of wood is as follows: Treads and risers, winders and risers, landings, running items of labour only, and then nosings to floors, apron linings, wall strings, outer strings, newels, hand rails, etc., according to scantlings. The number items of housing treads and risers follow. Fittings are usually placed

at the end of the joiner's work, those in deal before any in hardwood. The order of abstracting fittings is that given for general joiner's work.

33. Ironmonger.—Items of ironmongery are usually kept under three main headings, that fixed to deal, that fixed to hardwood, and sundry items. The order of abstracting the items in the first two divisions is: Wrought-iron, cast-iron, brass, and ball-bearing butts, which are arranged according to size; cross-garnets, strap hinges, swing hinges, barrel bolts, neck bolts, flush bolts, cupboard locks, latches, rim locks, mortise locks, door furniture, sash centres, sash fasteners, sash lifts, pull-down handles, casement fasteners, casement stays, sets of lines to open and close sashes, and sets of rod gearing. If in doubt as to where an item should go, it should be remembered that the rule is butts and hinges, bolts, latches and locks, door furniture and window fittings. Sundry items consist of the iron tongue for window sills, weather bars, iron dowels, iron dogs, etc.

34. Founder and Smith.—The abstracts of the founder and smith will have three main headings: cast iron, wrought iron, and steel. The order of cast-iron items should be: Columns, stanchions, and any other items which are to be billed as a weight; also patterns, which should follow their respective items, and any alterations to patterns; heads and shoes to roof principals, and patterns for the heads and shoes. Holes for bolts are placed according to the thickness of the metal and size of the bolts. Rain-water pipes are arranged according to size, with the numbered items following. Eaves gutters are arranged according to size the same as the last. Rain-water heads, pavement and stallboard lights, railings, coal plates and frames, balusters and newels, stoves and ranges, or a provisional amount for the same, are placed at the end of the cast-iron items. All items which are to be given as a weight should come first in wrought iron; these are such items as chimney bars, tie-rods, straps, screw bolts, grilles, railings, balusters, and newels. Other items, whether taken per foot run or by number, should be in the following order: Core rail, saddle bars, items of

extra labour on weighted-out items, rag bolts, screw bolts, gas-barrel distance pieces, hand-rail brackets, and other items of smith's work.

35. Where the steelwork is of a heavy nature, plenty of space must be left on the abstract paper for the weighting out previous to billing. Mistakes of a serious nature have often been made by the abstracts becoming so cramped and the figures so small that they were misread. The order of the items should be as follows: Rolled joists not exceeding $12'' \times 6''$ section at the respective floor or other levels; rolled joists over $12'' \times 6''$ section at the respective floor or other levels; rolled joists as cores to concrete lintels; then rods, angles, tees, channels at the several levels, riveted girders according to length, stanchions and columns according to height, roof trusses according to span. The number items should be as follows: Extra to countersinking rivet heads, planing or machining bearing surface, holes according to thickness of metal and size of bolts, slotted holes, ends of rolled joists, etc., notched and fitted, bolts, fish-plates, cleats, etc. Metal casements, or the provisional amount for same, should come at the end of the founder and smith abstract.

36. Gas-Fitter.—Gas-fitter's work can very often be billed direct. If this is done, care must be taken to make a note on the abstract paper in the place the item would have come had it been abstracted, so that at the time of billing it will not be forgotten. The order of gas-fitter's work should be: Gas pipe, according to size and beginning with the smallest; item of opening up ground; connection to main; siphons; stop-cocks; stop-cock pits; meters; connections to inlet and outlet of meters; fittings; and such items as holes through internal walls, etc.

37. Bellhanger and Electric Bells.—The work of the bell-hanger may be billed direct; the order should be: Bells with cranks, pulls, and wires, bell boards, and such items as for holes, etc. Another section that can be transferred direct to the bill is that of electric bells. The order should be: Wiring to points, bells, batteries, indicators, pushes, and such items as for holes, etc.

38. Electric Light, Heating, and Speaking Tubes.—Usually provisional amounts are included for electric light, heating, and speaking tubes. These should be copied on to the abstract paper from the dimensions, care being taken that the sums are transferred correctly.

39. Plasterer.—The abstract of plasterer's work should commence with whitening on ceilings and soffits, also on cornices, then should follow the distemper on walls. As these items are taken off at the same time as the plastering items and the same dimensions are used, time will often be saved by keeping the whitening and distempering with the plastering item on which

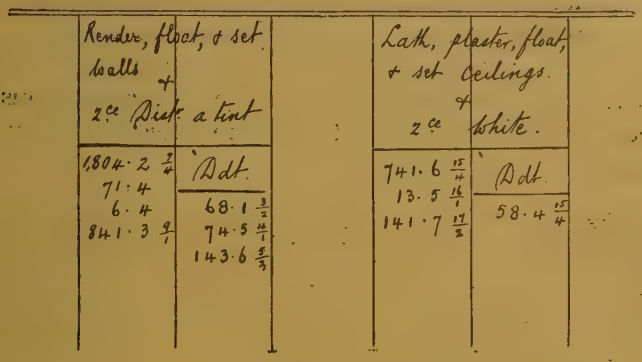

Fig. 5

it occurs; then, before the bills are written, a collection can be made on the abstracts of these items. This is shown in Fig. 5. Whether or not this is done, space must be left at the commencement of the abstracts for these items.

40. The actual plasterer's items should be kept in the following order: Rough render behind skirtings, plastering on walls, partitions, ceilings, sloping ceilings, soffits of stairs and landings, and flewing soffits of stairs. Moulded cornices at per foot superficial should follow. The running items are: quirk, arris, angles, mouldings and moulded cornices, and enrichments. The number items are stops, mitres, etc. to moulded cornices which have been measured per foot superficial, and centre flowers.

Sirapite and granite silicon plaster should follow the ordinary plaster, being kept under distinct headings. The order is the same as the foregoing. Keene's and other hard-setting cements should also be kept under a separate heading but taken in the following order: Plain face as dado, plain face in narrow widths to reveals, extra for angles, skirtings, mouldings, etc.

Portland cement should form another division on the abstracts; the items likely to occur should be kept in the following order: Floated beds for asphalt, tile, wood-block, terrazzo, and mosaic pavings; floated bed for asphalt to falls for flats; pavings; sloping bottom to coal shoot; items of labour only or extra labour and material; and skirtings. At the end of the Portland cement should be placed all the external work; this consists of rough-cast and plain-face work with all the sundry items in connection therewith. Wall tiling, etc., completes the plasterer's work; the order of superficial, runs, and numbers should be adhered to and the tile hearths put at the end.

41. External Plumber.—The milled lead to flats, gutters, hips, ridges, valleys, aprons, flashings, stepped flashings, secret gutters, dormer cheeks, etc., should be kept under one heading. Separate columns must be kept for the different weights of lead. Milled lead used for covering trap-doors, covering cornices, soakers, seatings, and other items where the labour, compared with the weight, is excessive, must be kept separate.

Other items of external plumbing should be placed in the following order: Welted edge, welted joint, extra-labour items, copper nailing, bossed ends to rolls, bossed intersections, lead dovetailed plugs, extra labour and solder to cesspools, soldered dots and outlet pipes. In the case of gratings to outlets, etc., the domical should come before any flat ones.

42. Zinc Worker and Coppersmith.—Placing the work in the order of superficial, runs, and numbers will be quite correct for the abstracts of the zinc worker and coppersmith.

43. Internal Plumber. — Commence the abstracts of the internal plumber with items of milled lead in lining to cisterns

and safes, soldered angles, copper nailing, and bossed or soldered angles. Lead pipes will have to be divided into sections according to their use. Commence with wastes, overflows, and antisiphonage pipes and follow with services, rising-mains, flushing, and soil and ventilating pipes. Under each of these sections arrange the items according to the method of fixing; for instance, pipes fixed with wall hooks should be placed before those fixed with lead tacks. The items should then be placed according to the diameter of the pipe.

Number items in connection with lead pipes would follow in this order: Bends, soldered stopped or dead ends, soldered joints to unions, branch soldered joints, soldered flanged joints, ornamental cut ends, beaded and cross-wired ends, connections to main, india-rubber cone joints, lengths of lead pipes, holes through roof slopes, and lead **P**, **S**, or other traps. For each of the foregoing the smallest size must come first. Wrought-iron pipes are placed before cast-iron pipes, and the bends, junctions, etc., in connection will follow. Covering pipes with hair felt comes afterwards.

Items of brass and other metal work should be kept in the following order, the smallest size always coming first: Stays to pipes, gratings, cowls or hoods to pipes, flaps and frames, cobweb or other gratings, gratings with plug and rim, unions, washers and wastes, standing wastes, thimbles or sleeve pieces, bib-cocks, stop-cocks, and ball valves. Fittings should be kept in the following order: Sinks, urinals, water-closets, lavatories, baths, feed-cisterns, water meters with pit and cover, and storage cisterns. Items of allowances for holes through internal walls, etc., and testing should come last.

44. Hot-Water Fitter.—The hot-water engineer's work can often be transferred direct to the bill. The order will be tubing, drilling boiler of range and connecting pipes, safety valves, connections to lavatory and bath wastes, cylinders and tanks, and items of attendance and testing.

45. Glazier.—Glazier abstracts should be arranged with the glass of the smallest value first. For instance, clear sheet glass will come before plate glass. Under each kind of glass arrange

in the order of fixing, that in putty to wood being followed with that with beads, with beads and washleather, and that to iron. All ordinary glass, except where in skylights, is arranged on the abstracts under the respective descriptions, according to the superficial contents of the squares, in stages of 2 feet superficial, as shown in Fig. 6. In the case of skylights, the length is given in inches, instead of the superficial contents. Any extra labour, such as circular cutting and risk, also copper clips and screws for the skylight glazing, will follow the particular kind of glass to which they refer. After the ordinary glass should come lead glazing, glazing strips, and patent glazing.

26 oz. clear sheet glass & glazing in wood in squares not exceeding			
2'. 0"	4 . 0"	6'. 0"	
18 . 0 $\frac{7}{4}$	13 . 9 $\frac{9}{1}$	25 . 6 $\frac{10}{1}$	
			12'. 0"
			11 . 9 $\frac{15}{4}$
Ditto with beads (m. s.) in wash leather in door panels			
2'. 0"		6'. 0"	
11 . 3 $\frac{3}{4}$		15 . 3 $\frac{5}{2}$	

FIG. 6

46. Painter.—The general order of the abstract for painter's work is: painting on steelwork and ironwork, on cement and plaster, and on woodwork. Staining and varnishing, french polishing, and writing are placed at the end. Blacking stoves, ranges, furnace work, soot doors, etc., should come directly after the painting on steelwork and ironwork. For painting on steelwork and ironwork, the paint before fixing must come before that after fixing. In each of the foregoing divisions, the work should be placed in the order of superficial, runs, and numbers.

Excavator & Concretor.

House

Sup

Excavate over surface one spit deep and wheel and deposit where directed on site n.e. 3 runs.

826·0 $\frac{1}{9}$

Yd. S.
92

Cube

Excavate over surface avge 5'·0" deep (nowhere exceeding 8'·0" deep) & cart away.

12,000·0 $\frac{1}{11}$
33·4 $\frac{1}{42}$

12,033·4

Yd. C.
446

Cube

Excavate to form surface trenches n.e 4'·0" deep and r.f. in & ram to foundations.

612·10 $\frac{1}{23}$
5·6 $\frac{1}{28}$

618·4
304·11

313·5

Yd. C.
12

Ddt

265·10 $\frac{1}{23}$
8·7 $\frac{1}{28}$
24·3 $\frac{1}{35}$
6·3 $\frac{1}{42}$

304·11

Ditto and cart away.

277·4 $\frac{1}{23}$
265·10
2·0 $\frac{1}{28}$
8·7
24·3 $\frac{1}{35}$
6·3 $\frac{1}{42}$

584·3

Yd. C
22

Sup

Planking & stri
to sides of exca

1,000·0 $\frac{1}{11}$

Run

P & S to b s of
2'·6" wide & 2'·
deep:

47·11 $\frac{1}{23}$

D°
wide
3'·9

52·

Sup

Layer of hard
broken stone o
4" thick fi
levelled, &
rammed inc
levelling & ra
ground unde

135·2 $\frac{1}{42}$

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Cube		Sup		Run		
P.6. Concrete in foundations as described.		Layer of P.6. Concrete (1-6) 6" thick spread & levelled under floors.		R.C. lintel 9" on soffit and 12" high Composed of 1 part of P.C. to 5 parts of Coke breeze including mould & hoisting & setting, the steel joist cores are M.S. (Brickwork has not been deducted)		Ex over ordinary brickwork to h.c. fixing bricks.
277·4 $\frac{1}{23}$		135·2 $\frac{1}{42}$		6·6 = 1 $\frac{2}{32}$		10 $\frac{2}{32}$
2·0 $\frac{1}{28}$						8 $\frac{2}{34}$
279·4						18
Yd.C.		Yd.S.				
10		15				
				Ditto 9" on soffit & 6" high with & including two 2"×2"×$\frac{1}{4}$" T's as cores running the whole length of lintel.		
				4·0 = 1 $\frac{2}{34}$		

House

Bricklayer.

Brickwork in mortar.							
1 Brick.		1½ Brick.			Horizontal d.p. Course consisting of 2 Courses of stout slates in cement laid to break joint (measured net width of wall)		
24 · 0 $\frac{1}{23}$	Ddt.	12 · 0 $\frac{1}{23}$	Ddt.				
119 · 10	49 · 6 $\frac{2}{32}$	39 · 5	· 4 $\frac{1}{28}$		97 2 $\frac{1}{23}$		
39 · 5	23 · 0 $\frac{2}{34}$	183 · 9	13 · 6 $\frac{2}{32}$		3 · 2 $\frac{1}{28}$		
63 · 8 $\frac{1}{35}$	72 · 6	15 · 0 $\frac{1}{42}$	13 · 10		12 · 2 $\frac{1}{35}$		
3 · 9 $\frac{1}{42}$		6 · 10			6 · 3 $\frac{1}{42}$		
· 5 $\frac{2}{32}$		257 · 0			5 · 0		
251 · 1		13 · 10			4 · 3		
72 · 6		243 · 2			128 · 0		
178 · 7		119 · 1					
59 · 6 = $\frac{1}{3}$rd		11 · 9					
119 · 1		374 · 0					
		Rod. feet 1 · 102					
				E.O. in cement.			E.L. b & f
				1 Brick.			1 $\frac{2}{32}$
				3 · 9 $\frac{1}{42}$			
				1 · 3 = $\frac{1}{3}$rd			
				2 · 6 Red.d			
		Cube			Run		
		13 · 3 $\frac{1}{28}$			R.C. birdsmouth		
		1 · 6 = $\frac{1}{9}$th			8 · 6 $\frac{1}{28}$		
		11 · 9 Red.d					
				H B sleeper wall in cement built honeycomb.		9" × 3" Galvanize b I air brick of approved patter building in inclu forming flue thr 14" wall rendered cement & m.g ex facing.	
				15 · 0 $\frac{1}{42}$		5 $\frac{1}{42}$	

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Facings.

up
Extra (over ordinary brickwork) to facing with best red pressed bricks & pointing as the work proceeds with a flat struck weather joint.

0 8 · 0 1/35
61 · 6
46 6

Ded
40 | 5 2/32
6 | 2
11 · 4 | 3 | 7
61 · 6

on
ir skewback cutting red pressed facing.

2 · 6 2/32

Two Circular cutting.

5 · 6 2/32

M & G facing to ends of window sills

2 2/32

Sup
Extra (over ordinary brickwork) to facing with Luton brindled bricks to in small quantities to quoins & aprons under window sills the joints raked out & pointed at completion with a neat struck weather joint in cement

7 · 1 2/32
11 · 4
3 · 7
22 0

Extra (over ordinary brickwork) to fair axed segmental arches in Luton brindled bricks & pointing to match facing.

2 · 1 2/32
6 · 2
8 · 3

Run
Narrow returns & pointing to edges of aprons.

6 · 3 2/32

Sup
Extra (over ordinary brickwork) to facing with Staffordshire best blue plinth & bricks to pointing as described to external facings..

128 · 8 1/35

Run
Extra over to splayed high (as sk) pointing to match facing.

73 · 6 1/35

Ex. to external angles.

4

Carpenter.

Hou

Run	Cube	Sup
Turning piece to 4" 1/2 segmental soffit.	Fir in wall plates.	1 3/4" × 3/4" Sawn battens for plain tiling. to 4" gauge.
4 · 9 2/32	9 · 11 2/5	1,237 · 6 2/7 40 : 6
		1,278 · 0
	Fir in ground joists & sleepers.	3/4" Deal roof boarding edges shot.
	4 · 3 1/42 9 · 0	1,237 · 6 2/7 40 · 6
	13 · 3	1,278 : 0
	F. F. in floor.	
	25 · 1 1/44 3 · 0	
	28 · 1	
	F. Fin roofs.	
	63 · 11 2/5	

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un							
abour splayed edge 3/4" boarding.						Eaves tilting fillet out of 5" × 2"	
.20·0 2/7	D° × grain					125·0 2/7	
	162·0 2/7						
			1½" × 2" Herringbone strutting to 9" joists (joists not deducted)				
			20·0 1/45				
						Sup Inodorous roofing felt well lapped & nailed. (measured net - no allowance made for laps.)	
						1,23·7·6 2/7 40·6	
						1,278·0	
						yd. S. 14 2	

Joiner.

House

Sup		Run	+ (4s)	Sup	
1" Deal wrot grooved & tongued flooring with splayed headings including glued & mitred margins to hearths (hearths not deducted)		1" x 9" Deal wrot & moulded skirting on & including grounds & backings plugged		Deal cased frame consisting of 1" inner & outer linings, 1¼" pulley stiles & head, back linings, parting beads & slips, 7¾ x 3½	
			Ddt	Teak sunk twice weathered throated & check throated projecting sill grooved for metal tongue, 2" deal moulded sashes each in 1 squares with 1½ moulded bars, d.h. with best bra axle pulleys, flax lines, and iron weights, the bottom bead 2" high tongue to the teak sill including groove, the bottom edge of bottom sashes splayed & hollow grooved and th meeting rails of sashes splay rabbeted, the head linings about 5½" high to clear the rise of segmenta arches.	
144.5 $\frac{1}{42}$	D° & bearers in openings..		3.3 $\frac{2}{34}$		
	2.5 $\frac{2}{34}$				
			Housed or fitted ends.		
			2		
			+ (4s)		
		1¼ x 11" Deal wrot & moulded skirting on & including grounds & backings plugged.			
			Ddt		
			3.3 $\frac{2}{34}$	49.6 $\frac{2}{32}$	Extra to moulde horns to 2" sashe
					2 $\frac{2}{32}$
			Housed or fitted ends.	2" Four panel moulded both door the two upper panels of for glass each panel in squares with & including g mouldings mitred round fixed with brass cups &	
			2		
				21.7 $\frac{2}{34}$	

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		Run					
rot dow ngs ued one to ne luding ve & ued at les inc kings. 8 $\frac{2}{32}$			$\frac{3}{4}$" × 3" framed & splayed grounds. 24·0 $\frac{2}{32}$ 18·5 $\frac{2}{34}$ 42·5		1½ × 3" Moulded and mitred architrave. 18·5 $\frac{2}{34}$		
					1½ × 3" Moulding tongued in to underside of window board including groove. 6·0 $\frac{2}{32}$	R. M. ends 2	
			$\frac{3}{4}$" × 3 W.f. moulded & splayed grounds. 18·5 $\frac{2}{34}$				
rot & ulded ndow d tongued ak sill luding ve & rers. ·0 $\frac{2}{32}$							N.R. R ends to 1¼ moulded window board. 2 $\frac{2}{32}$
					1½ × 4" Moulded & mitred architrave. 24·0 $\frac{2}{32}$ 18·9 $\frac{2}{34}$ 42·9	Extra to splayed & dovetailed plinth blocks 11" high. 2	
rot stongued beted eaded ings gued at gles cluding ckings. 4·6 $\frac{2}{34}$							

For painting on woodwork two columns of abstract paper at least will be required for the ordinary superficial quantity; one column will be used for that work which must be divided by 9 to bring to yards and the other for work that must be divided by 8.

47. Paperhanger.—The guide for the order of the abstract for paperhanger will be the cost per piece, the cheapest qualities coming first. After the ordinary paper should follow the French, Lincrusta Walton, etc. Sizing and varnishing wall paper should come at the end.

EXAMPLES OF ABSTRACTING

48. Explanation of Examples.—The examples of abstracting shown in Figs. 7 to 10 will give some idea of the method of abstracting the trades of excavator and concretor, bricklayer, carpenter, and joiner. All the items used are taken from the examples of taking off given in *Quantities and Estimating*, Parts 1 and 2. The setting out of these abstracts must not be taken as correct for the amount of space required between the items of any trade, for the object has been to give an example of as many items as possible consistent with the order being correct.

The method of referencing the items of these examples has been to take the part number as if it were the number of a sheet of dimension paper and the figure number as if it were the number of the page of that sheet. For instance, the first item in Fig. 7 has a reference $\frac{1}{9}$; this means that the item has been taken from *Quantities and Estimating*, Part 1, Fig. 9. In abstracting, the description of the item is first transferred from the dimension paper, Fig. 9, Part 1, to the abstract paper, Fig. 7, and a line is drawn beneath it. The amount in the squaring column, 826 feet, is then placed beneath this line; the abbreviation Sup. is written above the description to show the method of measurement. Then, as the abstracting of this item is finished, the item is cut out on the dimension paper by means of the vertical line in the squaring column, as shown in Fig. 1.

49. The reference of the second item in Fig. 7 shows that it is taken from Fig. 11, *Quantities and Estimating*, Part 1; as

the first column of Fig. 11 is filled with a waste, it may be ignored. On the dimension paper, the second item has several amounts for the one description; these must be added together before the item is entered on the abstract paper. The planking and strutting item is abstracted under its proper heading, as shown in Fig. 7.

50. In Fig. 23 of *Quantities and Estimating*, Part 1, is given an example of taking off external walls. The first item has two amounts and the two descriptions are applicable to the total of the two amounts. The first description is for surface trench and cart away. Therefore, on the abstract paper, Fig. 7, surface trenches will follow the surface excavation, and the description is written down so as to include for "return, fill, and ram." Below this is written the item for "cart away." The second description is foundation concrete, which forms the first item of concrete on the abstract paper. The second item on the dimension paper has two amounts; these must be added and put under the heading "surface trench, and return, fill, and ram." All of the last set of dimensions in the first column is a deduction from the last item and an addition to the previous item of surface trench and cart away. Since the first two items of the second column of the dimension paper are planking and strutting, they are placed on the abstract paper beneath the proper description, which is written under the planking and strutting item previously abstracted.

The next four dimensions in Fig. 23, Part 1, belong to the bricklayer's abstract, Fig. 8, and all quantities must be reduced to 1 brick and $1\frac{1}{2}$ bricks. As the first item is $1\frac{3}{4}$ bricks the full amount is placed once in the 1-brick column and one-half the amount is placed in the $1\frac{1}{2}$-brick column. The next item is placed in the 1-brick column. Place the $2\frac{1}{2}$-brick item once in the 1-brick and once in the $1\frac{1}{2}$-brick column; the $1\frac{1}{2}$-brick item is placed in its proper column. The last item on the dimension paper is the damp-proof course; this is placed at the end of the superficial items of the bricklayer's abstract.

51. All the items in the first column of Fig. 28 of *Quantities and Estimating*, Part 1, are entered in the proper columns of

the excavator and concretor abstract, Fig. 7. Since the first item of the second column is a deduction of ½ brick, it must be divided by 3 and the result placed in the column of 1½-brick deductions of the bricklayer's abstract, Fig. 8. The next item is placed under the heading "cube"; the item of rough-cut birdsmouth is the first of the running dimensions on this abstract. The last item is simply added to the damp-proof courses previously abstracted.

An example of external facing is given in Fig. 35 of Part 1. To reduce the first item to 1-brick dimensions, it must be divided by 4. The next two items have been previously explained; one will be found with the damp-proof course on the bricklayer's abstract, Fig. 8, while the two descriptions of digging are placed in the excavator and concretor abstract, Fig. 7. One of these is placed among the deductions. The first two items of the second column are placed near the end of facings in Fig. 8; the latter item is an extra over the first and follows it. The external angles to the last item give an instance of writing short on the abstracts. The last item on Fig. 35 is for facing above the plinth and should be considered as the general description of facing; it is therefore placed at the beginning of facings on the bricklayer's abstract.

52. When abstracting the items on the dimension paper shown in Fig. 42 of *Quantities and Estimating*, Part 1, deduction must be made from the first item for the amount of the second. The first item is then added to the cubic surface excavation already taken on the excavator and concretor abstract, Fig. 7. The next items have two descriptions, the first of which is placed after planking and strutting but before concrete, and the other after the cubic item of foundation concrete. All the remaining items in the first column and the first six items in the second column of the dimension paper belong to the bricklayer's abstract, Fig. 8, with the exception of the fourth, which must be placed in the excavator's, Fig. 7. The last item in the second column is placed in the carpenter's abstract, Fig. 9. The dimensions shown in Fig. 42 (*b*), Part 1, is a continuation of that shown in Fig. 42 (*a*). The first item is an addition to the last

item of (*a*), and will be found in the carpenter's abstract, Fig. 9. The item of flooring is the first on the joiner's abstract, Fig. 10, and the item of air bricks must go at the end of the bricklayer's numbers, Fig. 8.

53. All the items on the dimension sheet shown in Fig. 44, *Quantities and Estimating*, Part 1, belong to the carpenter's abstract, Fig. 9 ; the description is the first of the framed-work items. The only item in Fig. 45 of Part 1 is placed near the end of the carpenter's abstract, Fig. 9, while in the cube columns are also placed the items shown in Fig. 5 of Part 2.

As some of the items in Fig. 7 of Part 2 belong to the tiler, they are not shown in these examples of abstracting. The first two dimensions added together give the result for all four descriptions ; the first three, roof boarding, felt, and battens, are placed on the carpenter's abstract, Fig. 9, the last, roof tiling, is for the tiler's abstract. The next dimension must be added to each of the three foregoing items. The first two items in the second column are for the carpenter's runs, but the next three items are for the tiler's abstract. The first description to the last dimension is another item for the carpenter, but the other description belongs to the tiler.

54. Items for nearly every trade are found in the examples of taking off of a window given in Fig. 32 (*a*), (*b*), and (*c*) of *Quantities and Estimating*, Part 2. The first three items in Fig. 32 (*a*) belong to the bricklayer's abstract, Fig. 8. As the first is a deduction of brickwork and facing, its amount for the brickwork deduction must be divided by 3 and the result put in the column of $1\frac{1}{2}$-brick deductions. Being a " use-and-waste " item furnished by the carpenter, the turning piece is the first item entered on the carpenter's abstract, Fig. 9. All the remaining items in the first column and the first item in the second column are for the bricklayer, and are placed under the facings in Fig. 8. The item of window sill and the ends following are for the mason's abstract, an example of which is not given. The make good facing to ends of sills will be found in the bricklayer's abstract, Fig. 8. The next dimension represents three items : The first is an addition to the special facing ; the second is a

deduction from the general facing ; the third is an addition to the ordinary brickwork, which is divided by 8 and the result placed in the 1-brick column. The narrow-return item is placed after the facings. Fixing bricks belong to the excavator and concretor abstract, and, in Fig. 7, follow the other items of concrete. Frames, bed and point, are put in the numbers of the bricklayer, Fig. 8.

55. The first dimension in Fig. 32 (*b*) is a deduction from two items ; the first belongs to the bricklayer and is placed in the 1-brick column of Fig. 8 ; the other belongs to the plasterer. Concrete lintels belong to the excavator and concretor abstract, Fig. 7, but the core would go under the heading of steel in the founder and smith's abstract, which is not shown. The galvanized-iron tongue should be placed among the sundries of the ironmonger. The item of deal-cased frame and the moulded horns following will be found on the joiner's abstract, Fig. 10. The remaining items in Fig. 32 (*b*) belong to the ironmonger, and should be abstracted in the order given for that trade.

The items of glass at the beginning of Fig. 32 (*c*) must be abstracted for the glazier. Of course, the sheet glass will come before the fluted. All the other items in the first column and those at the beginning of the second column are for the joiner, and will be abstracted as shown in Fig. 10. The remaining items in Fig. 32 (*c*) are for the painter, and should be abstracted in the order given for this trade.

56. In Fig. 34 (*a*) and (*b*) of *Quantities and Estimating*, Part 2, are given the dimensions for an internal doorway. Since the first item in Fig. 34 (*a*) is a deduction of common brickwork, it will be found in Fig. 8. The next four items are the adjustment for skirtings and will be found in Fig. 10 ; the painting on the skirtings is usually kept with the item, as in Fig. 10, until the bills are written, when the total amount is transferred to the painter's abstract. The next item is a deduction of plastering, the abstract of which is not shown. The next item in the first column should be placed after the item of ordinary flooring in the joiner's abstract, Fig. 10. The concrete lintel and fixing bricks must be placed on the excavator and concretor abstract,

Fig. 7. The first two items in the second column are joiner's items and will be found in Fig. 10. Since the last three items are for ironmonger and glazier, they must be abstracted in the order given for these trades. The items in the first column of Fig. 34 (*b*) must be placed in the joiner's abstract, Fig. 10. The items in the second column belong to the painter.

CASTING AND REDUCING

57. Explanation of Casting and Reducing.—After all the items have been transferred from the dimensions to the abstract paper and checked, the abstracts are then **cast and reduced.** This means that the columns are added up, the deductions made, and, where necessary, the amounts reduced to yards, rods, etc., so that they will be ready for billing. The work must be carefully checked, no matter how carefully the work has been done up to this point. If the casts and reducings are not also carefully checked, all the care taken previously is wasted; for instance, deductions may be added instead of subtracted; cubic measurements reduced to yards by dividing by 9 instead of 27, or superficial measurements brought to yards by dividing by 27 instead of 9. Before casting or reducing is commenced, the abstracts should be examined to see that all the amounts have been checked; any amounts remaining unchecked should be found on the dimensions. Sometimes it will be found that amounts have been put under a wrong heading when abstracting, and that the person who checked the abstracts had written the amount under the correct heading, but had not cut out the amount from under the wrong one.

58. Method of Casting and Reducing.—All casts and reductions should be made in red ink and the checking in black ink. The work in Figs. 7 to 10 is shown in black only for convenience in printing. Where the casts are exceptionally long, they should be divided either when making the casts or when checking.

When the deduction column to an item has been transferred to and subtracted from the amount of the additions, the column should be cut out by drawing through it a vertical line, finished with a loop, as shown in the item of excavation to surface

trenches in Fig. 7. The loop is used to distinguish this cutting-out line from that used for billing.

59. Reducing to Yards.—When reducing amounts to yards it is a safeguard to state whether the amounts are cube or superficial; this may be done by using *yd. c.* for yards cube and *yd. s.* for yards superficial, as shown in Fig. 7. To reduce cubic measurements to yards, divide by 27; to reduce superficial measurements to yards, divide by 9; and to reduce running, or linear, measurements to yards, divide by 3. Half-yards do not usually appear in the bill, the general rule being that if the amount over when reducing is $\frac{1}{2}$ yard, or more, the next yard is allowed, but when the amount is less than $\frac{1}{2}$ yard, it is ignored. This rule, however, must not be considered a hard-and-fast one for small works, for the ignoring of many amounts approaching $\frac{1}{2}$ yard will be a very serious item. In cases like this the next yard should be allowed or the $\frac{1}{2}$ yard should appear in the bill. Items which are to appear in the bill in squares of 100 feet superficial are not usually reduced on the abstract, as the number of squares is so easily found from the amount.

60. Reducing Brickwork to Rods.—Generally, the common brickwork has to be reduced to *rods*. In London and some of the provinces a **rod** contains 272 feet superficial of brickwork $1\frac{1}{2}$ bricks thick; this equals 408 feet superficial 1 brick in thickness, or 306 feet cube. If there is any likelihood that the estimator may not understand the rod, a note should be inserted at the beginning of the bricklayer's bill to the effect that "the brickwork over $\frac{1}{2}$ brick in thickness has been reduced to standard rods of 272 feet superficial $1\frac{1}{2}$ bricks in thickness." This explanation will show that the totals of all the columns which are not $1\frac{1}{2}$ bricks must be reduced to this thickness and added to the amount of the $1\frac{1}{2}$ bricks before the number of rods can be found. This is done by deducting one-third from the amount of 1 brick and deducting one-ninth from the amount of cube, as shown in Fig. 8. Both of these rules can be proved by taking the contents of a rod given above; for instance, 408 feet of 1 brick minus one-third equals 272 feet, and 306 feet cube minus one-ninth equals 272 feet.

Should the brickwork have to be given in yards cube, all the brickwork should be taken off per foot cube ; but if this is not done, the $1\frac{1}{2}$ bricks can be reduced to feet cube by adding one-eighth, and the 1 brick to feet cube by deducting one-fourth.

61. Reducing to Weight.—Items that must be billed in hundredweights, quarters, and pounds will also need reducing on the abstracts. In the case of leadwork where the weight per foot superficial is given with each item no difficulty will be found ; but in the case of ironwork and steelwork where the thickness of the metal only is given, it must be remembered that the various metals do not all weigh the same. The weights in general use for 1 foot superficial of metal 1 inch thick are cast iron, $37\frac{1}{2}$ pounds ; wrought iron, 40 pounds ; and steel, 40·8 pounds.

BILLING

62. Explanation of Billing.—Writing the bills, which is termed **billing,** is the final stage of working up. It is the transferring of all items from the abstracts to the bill paper, or, if abstracts are not used, direct from the dimension paper. In Fig. 11 is shown

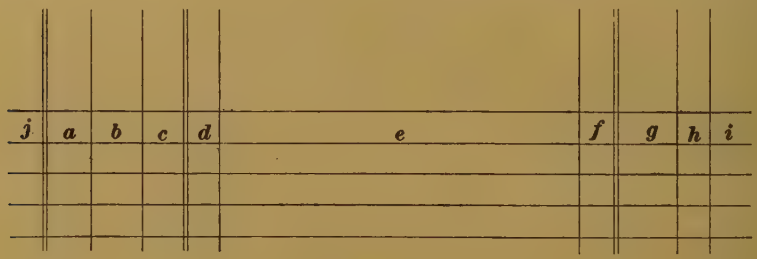


Fig. 11

a specimen of bill paper, which is foolscap size and ruled exactiy the same on both sides. Generally, only one side is used ; the other side is then free for any items that may have to be inserted. Columns *a* to *d* are used for the amounts ; column *a* is used for yards, squares, rods, or hundredweights ; column *b*, for feet or quarters ; column *c*, for pounds ; and column *d*, for stating whether the item is cube, superficial, or run, and for giving the

number in the case of number items. Column *e* is for the description. Columns *f* to *i* are left for the estimator, column *f* being used for the rate, and columns *g*, *h*, and *i* for the total in pounds, shillings, and pence.

63. Heading of a Bill.—The heading of a bill of quantities should state the nature of the work, the owner of the proposed building, the name and address of the architect, and the date.

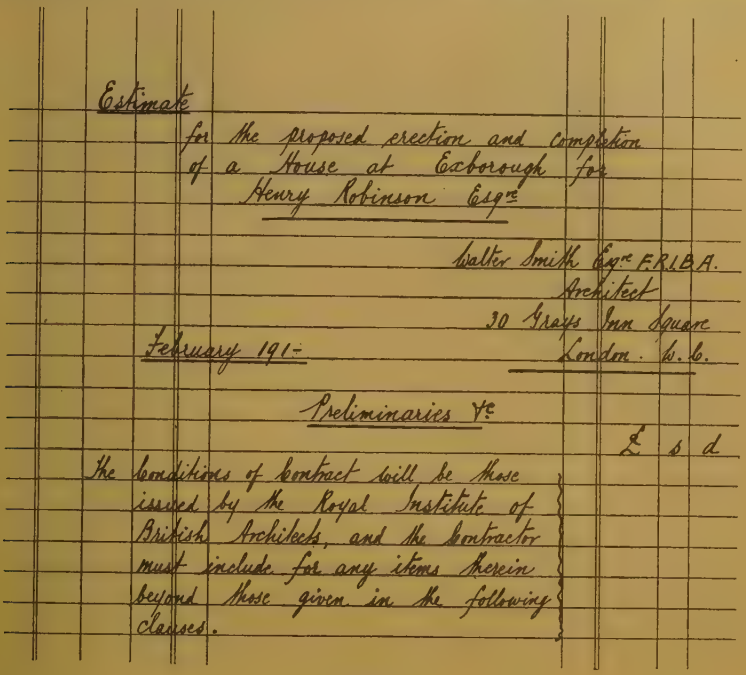


Fig. 12

Fig. 12 shows a suggested heading, as to style, also the commencement of the preliminary bill. Should the bills for all the trades, when put together, be considered too long to be bound in one volume, they should be divided into parts, or according to the various trades; these parts must then be numbered just above the name of the trade.

64. Endorsement of a Bill.—When a bill is completed, it is endorsed by writing the heading on the right-hand side of the

Estimate
for the proposed erection and
Completion of a House at
Exborough for Henry
Robinson Esqre

Walter Smith Esqre F.R.I.B.A.
Architect.
30 Greys Inn Square
London. W.C.

February 19--.

All Trades and Summary.

The drawings specification and
conditions of Contract may be
seen at the office of the
Architect.
The Tenders are to be delivered
as addressed on or before
Monday 14th March 19-- at
11 o'clock A.M.

Jones & Brown
Surveyors
59 Grays Inn Square
London. W.C.

FIG 13

last page, so that, when the bill is folded, the **endorsement** shows what it contains. It must always bear the signature of the person responsible for the quantities. The usual style followed is shown in Fig. 13.

65. Preliminaries and Preambles.—The first bill contains the **preliminaries**; these consist of all the general items from the beginning of the specification, all items from the conditions of contract that have to be priced, and items giving information that may influence the price of other items. This bill varies with every building, but it usually contains information as to the position of the site, date of completion and penalty for delay, rate of payment; states that a priced copy of the quantities is to be deposited with the architect to form a schedule for variations; that a foreman must always be on the work, and provides for giving notices to all authorities, depositing plans and paying fees, scaffolding, tools, tackle, etc., office and attendance for clerk of works, latrines for workmen, sheds for workmen and materials, hoarding and other enclosure to site, protection of adjoining buildings, watching and lighting, clearing and carting away all rubbish, etc., casing and protecting all work, keeping buildings in repair, sureties for completion of the work, explanation of prime cost and provisional sums, etc.

The provision for contingencies is usually entered at the end of the bill of preliminaries, the amount being one to which the estimator must not add anything for profit. The amount should also be placed in the money column of the bill.

66. The term **preambles** is applied to the general descriptions at the beginning of each trade describing the materials, workmanship, etc., all of which are obtained from the specification. When necessary, a statement as to the method of measurement of some items should follow the preambles.

67. Method of Billing.—When the preliminaries, preambles, etc., are written, the items on the abstracts can be billed in the order given for abstracting. For each item enter the amount in the proper columns, write the description in the bill from that on the abstract, and then cut out the item on the abstract by a

vertical line. The person who checks the bill will then compare the amount and the description with that on the abstract; if satisfied that all is correct, he will place a red-ink tick in the first column *j*, Fig. 11, of the bill and draw a red-ink slanting line through the item on the abstract. One line of the bill paper should be left blank between items that are measured differently, such as cube and superficial. In Fig. 14 is shown an item on the abstract which has been checked, a correction made and checked, the item cast, reduced, and checked, billed and cut out, checked again, and then cut out in red ink. The dotted lines and type figures represent the work that should be done in red ink in actual practice.

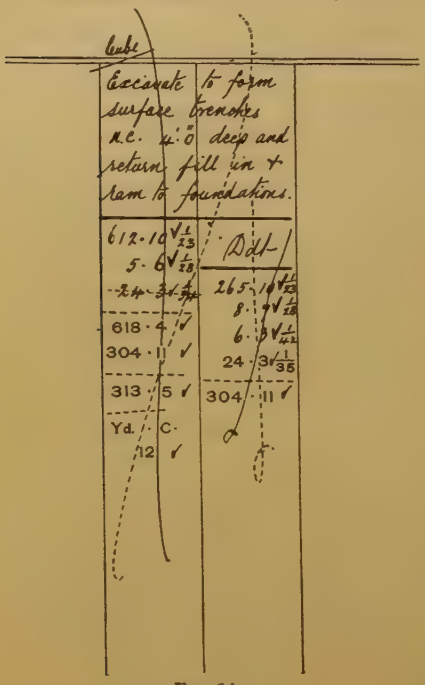


FIG. 14

68. Each page of the bill must be numbered, and as a safeguard the name of the job should be written in the upper left-hand corner. Except at the beginning or end of a trade each page should commence and end with "Continued £." The trades should commence with £ s. d., as shown in Fig. 12. Each description that occupies more than one line should be enclosed by a bracket, which is placed by the rate column. In Fig. 15 is shown the method of entering the different items on the bill paper.

69. When the amounts that must be entered in the bills have been reduced to yards, the number of yards is simply copied from the abstract. Where the amount must be given in feet, the rule is that when the amount contains 6 inches or more, the

Yards	feet			Continued £
12	–		Sub	Excavate to form surface trenches not exceeding 4'-0" deep and return fill in & ram to foundations
Rods				
1	102		Sup	Reduced stock brickwork in lime mortar as described.
	73		"	Rough cutting.
		Nº 5		9"×3" Galvanized cast-iron air bricks of approved pattern and building in including forming flue through 14" wall rendered in cement and make good external facing.
Squares				Deal
12	80		Sup	¾" Roof boarding edges shot.
	43		Run	12"×4" Moulded and mitred architrave. Nº 2. Extra to splayed and dovetailed plinth blocks 11" high.
Cwt	qr.	lb.		
15	3	14		Milled lead and all labour in gutters flats. flashings &c
				Provide the sum of £60 P.C. for Electric Lighting and add for profit.
				Allow for attending upon, cutting away for and making good after Electricians in all Trades to Nº 47 points.
				Continued £

FIG. 15

next foot is allowed ; but when the amount contains less than 6 inches, the inches are ignored. This rule must be carefully watched, however, for small work, as there may be a larger number of items with the amounts entered a few inches short than are counterbalanced by amounts for which 1 foot has been allowed. In the mason's work, especially, items frequently occur which are just over 1 foot cube ; if these few inches are ignored every time, the total feet cube in the bill may be considerably short of the actual amount required.

70. When amounts must be given in squares and feet, the parts of 5 feet are either allowed as the next 5 feet or entirely ignored. For instance, 1,177 feet will be called 11 squares 75 feet ; but 958 feet will be entered as 9 squares 60 feet. This method is a great help to the estimator in working out the cost of an item after filling in the rate per square, and the differences usually neutralize each other.

When amounts are given in hundredweights, quarters, and pounds, the parts of 7 pounds are either allowed as the next 7 pounds or entirely ignored. For instance, an amount on the abstract of 15 hundredweights, 2 quarters, 18 pounds will be entered in the bill as 15 hundredweights, 2 quarters, 21 pounds ; but an amount of 3 hundredweights, 1 quarter, 17 pounds will be called 3 hundredweights, 1 quarter, 14 pounds.

71. Clauses at End of Trades.—In addition to the items of attendance and testing, it has become the custom to put general clauses at the end of certain trades. These are not always priced by the estimator. This is done to avoid any claim being made should the architect have to ask for the work to be done at the completion of a job. The items are as follows :

Slater or Tiler.—Allow to clean out all gutters and leave all roofs complete and perfect.

Plasterer.—Allow to cut out all defects in plaster and make good and leave perfect.

Glazier.—Allow to clean all glass inside and out and leave perfect.

Painter.—Allow to touch up and leave all the work perfect on completion.

72. Finish of Trades and Summary. — Partly to avoid long continuous casts, and partly to know the total value of work in the respective trades, each trade is carried to a *summary* by writing at the end of the trade, instead of "Continued £," "Carried to summary £," as shown in Fig. 16.

A **summary**, as shown in Fig. 17, contains a list of all the trades for which there are bills, so that the estimator can fill in against each trade the totals arrived at from the bills. In addition to having a complete list of all the trades, the items for water and insurance are better put in the summary rather than, as is very often done, in the preliminary bill. The value of these items is usually found by using a percentage on the value of

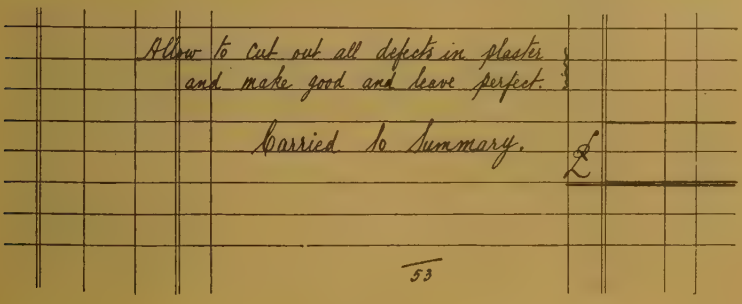


Fig. 16

the work. When the charges for the preparation of the quantities and the cost of preparing a sufficient number of copies of the bills for sending to competing contractors are to be paid by the builder, these charges must be included as shown in Fig. 17. In cases where these charges are to be paid direct by the employer, no mention should be made of them in the summary.

73. Tender. — The total amount of the summary, which represents the sum for which the contractor is willing to carry out the work, is transferred to a **tender**, which must be sent to the architect or other appointed person. A copy of the tender, together with an envelope for enclosing it, is usually sent with the copy of the bills to the competing contractors. Sometimes two copies of the tender are sent to each, so that

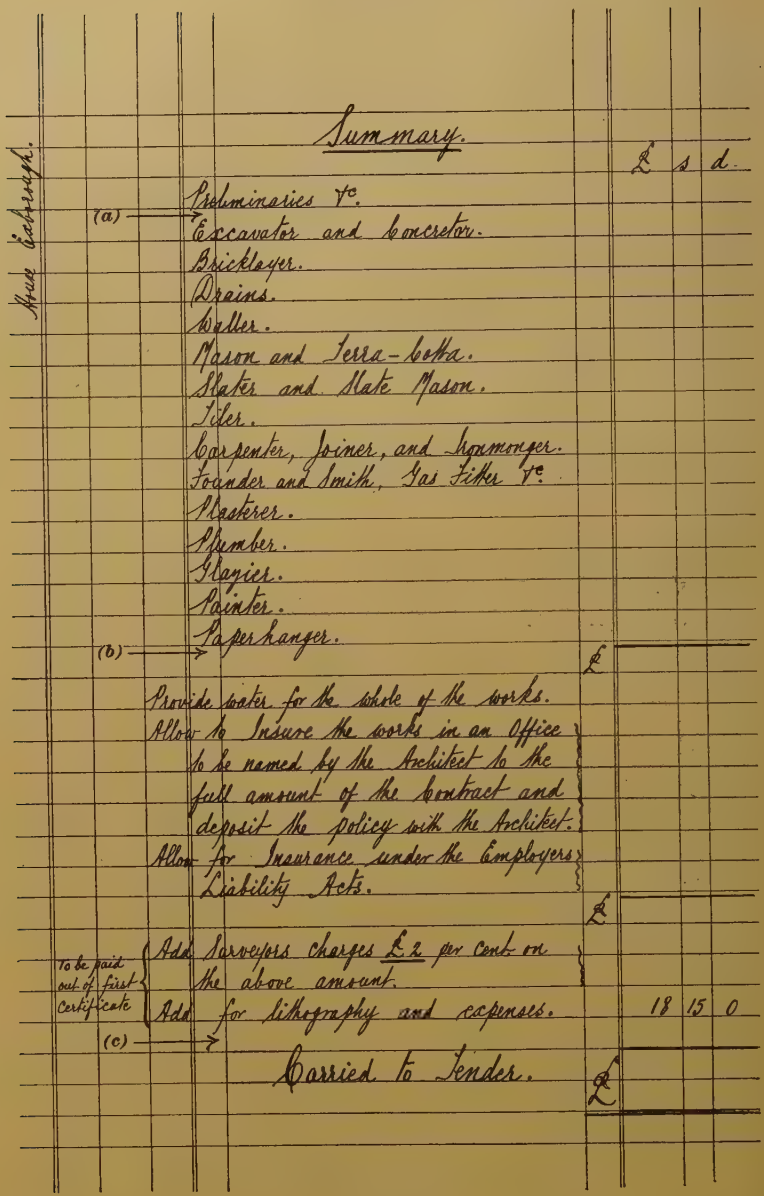

Bruce Edinburgh.
Summary.
£ s d
(a)
Preliminaries &c.
Excavator and Concretor.
Bricklayer.
Drains.
Roller.
Mason and Terra-Cotta.
Slater and Slate Mason.
Tiler.
Carpenter, Joiner, and Ironmonger.
Founder and Smith, Gas Fitter &c.
Plasterer.
Plumber.
Glazier.
Painter.
Paperhanger.
(b)
£
Provide water for the whole of the works.
Allow to Insure the works in an Office to be named by the Architect to the full amount of the Contract and deposit the policy with the Architect.
Allow for Insurance under the Employers Liability Acts.
£
To be paid out of first Certificate
Add Surveyors charges £2 per cent on the above amount.
Add for Lithography and expenses. 18 15 0
(c)
Carried to Tender.
£

FIG. 17

one can be kept by the contractor or used in case the other is spoilt. In Fig. 18 is shown a form of tender and in Fig. 19 an envelope, both of which are suitable for general use, but the form in which the tender is prepared varies considerably.

74. Schedule for Day Works.—There is a great diversity of opinion as to whether or not a schedule of prices for labour and materials in day work should be sent in by the contractor at the time of tendering. Of course, there are very few works carried out under a contract that do not involve at some stage or another a day-work return being necessary. If it is decided that such a schedule is desirable, it should take the form of a list of all the mechanics who are likely to be engaged on the work and also the labourers in all trades. In this list a space should be left so that the rate per hour may be filled in. A similar list of the most important and likely items of materials in each trade should follow, with a space left for the rate per yard, per bushel, per hundred, per foot, etc. Care must be taken to state that the prices are to include for profit, use of scaffold, and all tackle, tools, sharpening, water, and general foreman's time ; subordinate foremen are generally stated to be charged as ordinary workmen. The schedule should either follow the summary or form part of the tender.

75. Credit, or Spot, Bill.—When a building on the site of the proposed new one has to be pulled down, or when certain work must be done in connection with adjoining property, or where the work is an alteration job, a **credit, or spot, bill** must be prepared. The heading of this bill is generally "Pulling down and works to the existing buildings," and is termed, for conversational purposes, spot bill, because it contains such items as can only be valued by examination on the site, or spot. This bill should contain all the items of pulling down, alterations to old work, and, if necessary, the new materials necessary for carrying out any special alterations ; also the taking down, depositing, and refixing any finishings or fittings of the existing buildings. This bill must very clearly state whether all the materials resulting from the pulling down are to be carted away or deposited on the site for re-use, etc.

Tender for House at Exborough.

To
Walter Smith Esqre F.R.I.B.A.
Architect.
30 Grays Inn Square
London. W.C.

Sir

..... willing to Contract for and hereby undertake to execute the several works required to be done in the erection and Completion of a House at Exborough for Henry Robinson Esqre according to the drawings and Specification prepared by you and to your entire satisfaction for the sum of ..... pounds ..... shillings and ..... pence.
(£ " ")

As witness..... hand... this ..... day of March 191-

Name .....
Address .....
.....

The Employer does not bind himself to accept the lowest or any Tender.

FIG 18

76. The credit, or spot, bill is usually written on what is known as *double-ruled bill paper*. The size is the same as that of other bill paper, but there are two sets of money columns instead of one, consequently the description column is narrower. One pricing column, termed the *credit column*, is used for filling in the credit which the contractor is willing to allow for the old materials which are not to be re-used. The other pricing column is used for entering the value of the actual pulling down, alterations, new materials, removing debris and rubbish, etc. When it is necessary to give a detail of the building to be pulled down, the method of measurement for the old materials is entirely different from the measuring of new, except that brickwork is

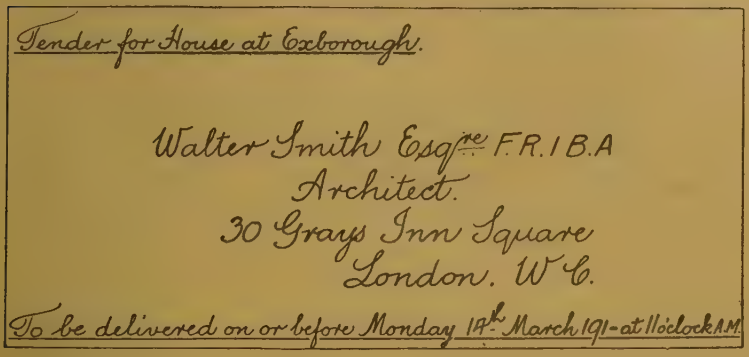

Tender for House at Exborough.
Walter Smith Esqre F.R.I.B.A
Architect.
30 Grays Inn Square
London. W.C.
To be delivered on or before Monday 14th March 191- at 11 o'clock A.M.

FIG. 19

measured per rod superficial. Roofing, including slating or tiling, and boarding and timbers are measured per square of 100 feet superficial, as for new work. Flooring, including joists, and quarter partitions are measured per square. Windows, doors, etc., including all finishings, are taken by number.

77. The credit, or spot, bill should either follow the preliminary bill or else come after all the other trades. If the bill is long, it should be bound separately from the other bills, so as to be conveniently handled and read while the estimator is walking through the building. Both columns of the credit, or spot, bill should be finished off in the same method as for other bills, except in cases where the amount of credit for old

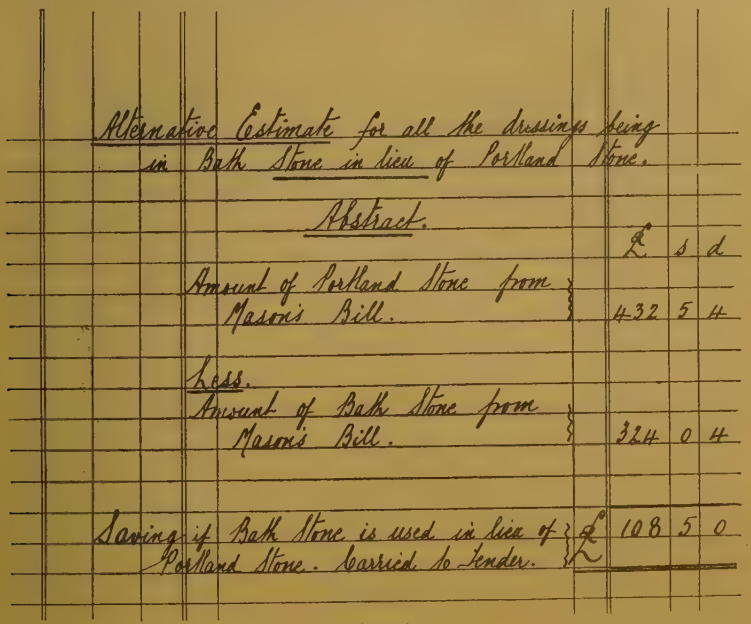
materials must be stated separately in the tender and not deducted in the summary. In these cases, instead of writing "carried to summary" at the bottom of the credit column, state "carried to tender." Of course, provision must then be made in the tender for the insertion of this amount. When the totals of both columns must be inserted in the summary, it is done by inserting either at (*a*) or (*b*), in Fig. 17, "pulling down and works to the existing buildings." This will be for the total of the column giving the cost of pulling down, alterations, new materials, etc. At (*c*), for the total of the credit column, insert "credit for value of old materials arising from the pulling down."

78. Separate Estimates.—When it is necessary that the cost of certain parts of the work should be readily known, this work must be kept in a **separate estimate.** All the items in connection with that work in all trades must be separated and arranged in the same order as in the trades generally. The total value of the work should be carried to the summary directly following all the trades, except in cases where the amount must be stated separately in the tender. In the latter case, the tender must be so prepared as to leave space for the amount to be filled in. Separate estimates are sometimes required for such items as: library or other fittings, boundary walls, railings and gates round the site, ground work round a building, tower or flèche above roof level.

79. Alternative Estimates.—**Alternative estimates** must be prepared in cases where an alternative price is required for executing some work in a different way or with different material than that included in the general bills. These estimates must be prepared for so many purposes that it is impossible to give a complete list of those likely to occur in general practice; but the following have often to be prepared: (*a*) Features of the elevation in brick in lieu of stone; (*b*) stone front or dressings in different kinds of stone; (*c*) different kinds of facing bricks; (*d*) finishings to certain positions in different woods; (*e*) ordinary plastering in lieu of cement or hard-setting plaster; (*f*) Welsh slating in lieu of green Westmorland; (*g*) roof in fir instead of oak.

When alternative estimates are necessary, the more costly work should be included in the general bills, so that these estimates will always appear as a saving on the amount of the tender. These estimates should always follow the summary in the bill of quantities. When alternative estimates have to be prepared, the tender must be drawn up so that spaces will be left for the results of the estimates.

80. The preparation of alternative estimates need much thought and careful arrangement. Where an alternative price is needed for all the items of one material, such as stone dressings, for instance, the portion of the bill that is to have alternative prices may be prepared on double-column bill paper.



Alternative Estimate for all the dressings being in Bath Stone in lieu of Portland Stone.

Abstract.

	£	s	d
Amount of Portland Stone from Mason's Bill.	432	5	4
Less. Amount of Bath Stone from Mason's Bill.	324	0	4
Saving if Bath Stone is used in lieu of Portland Stone. Carried to Tender.	£ 108	5	0

FIG. 20

The price of the various items in one quality of the material will then be placed in one column and the price of the alternative quality will be placed in the other. The total of the first quality should then be carried to the summary and also to an abstract at the end of the bills that bears the heading alternative

Alternative Estimate for the finishings in Dining Room being in Deal in lieu of Oak.

			Oak £	s	d		Deal £	s	d
	Here would follow all the items in order of the Joiner's Bill.		115	4	3		79	6	2
	Ironmongery including screws and fixing.								
	No 2 Pair 4" Knot iron butts.		—	—	—	1/3		2	6
	" 2 " 4" Brass ball bearing butts.	6/-		12	0		—	—	—
Yards feet 35 -	Sup Knot prime stop and paint four coats of oil colour in addition on woodwork.		—	—	—	1/3	2	3	9
280	" French polishing.	6d	7	0	0		—	—	—
	Carried to Abstract below.	£	122	16	3	£	81	12	5

Abstract.

	£	s	d
Value of work in Oak.	122	16	3
less.			
Value of work in Deal.	81	12	5
Saving if Deal is used in lieu of Oak Carried to Tender. £	41	3	10

FIG. 21

estimates ; the total of the alternative quality should be carried to the abstract only. In Fig. 20 is shown an alternative estimate prepared in this manner

81. Often when an alternative estimate must be prepared, for instance, finishing certain portions in deal instead of in oak, the alternative estimate must be prepared on double-column bill paper and form a bill quite distinct from the bills of trades generally. Care must be taken that this estimate contains not only the items that are already contained in the general bills, but also all the items that will apply under one condition but not under the other. For example, in the case of deal and oak, painting or staining and varnishing on deal must replace all polishing and fuming that may have been measured separately on the oak. The ironmongery, even if of the same quality, must be fixed to deal instead of to hardwood. In Fig. 21 is shown the arrangement of an alternative estimate on the foregoing lines.

In cases like the foregoing, of course, the items in the column which are in the same material as that in the general bill will have the same rates or prices filled in, and only the alternative items will need new rates or prices. Avoid, if possible, having either column of an alternative estimate headed " less cost " or " extra cost " of one material over a different kind.

VARIATIONS OR ACCOUNTS

GENERAL INFORMATION

82. Definition.—When a bill of quantities has been prepared, a tender accepted, and the work carried out, generally there are several questions that must be discussed, measurements made, and the total amount agreed on before the final certificate is granted by the architect to the builder. These measurements and the bills prepared from them are described as **variations and accounts.** Whenever possible, they should be prepared by the same person who prepared the original bills of quantities.

83. Documents and Information Required.—It will depend very much on the extent of the variations as to what documents and information will be required to prepare the final accounts properly, but some, if not all, of the following will be necessary: (*a*) Drawings from which the bills of quantities were prepared; these should agree with the contract drawings. (*b*) Deposited priced bills of quantities forming the schedule for variations. (*c*) When the conditions of contract state that no extra will be allowed unless a written order has been given by the architect, these orders, known as **variation orders,** or authenticated copies of the same, must be produced, as they are in this case the only instructions for variations or extras. (*d*) A list from the architect, clerk of works, or foreman, or from all in special cases, of items that have been varied during the execution of the works from what was included in the contract; also notes of measurements and materials in connection with variations made as the work was progressing, but which were covered up and not exposed to view when the bill of variations was being prepared. (*e*) Invoices and receipts so as to adjust properly the prime cost and provisional sums in the bills of quantities. (*f*) All the day-work vouchers which should have been sent to the architect week by week for his signature and verification.

84. Method of Procedure.—The method of procedure with regard to the preparation of the final accounts will vary with the builder who has carried out the work. Some builders are satisfied with examining the variation bill, in which case the person who prepares the bill acts for both the builder and the architect. Most of the work is done in the office, and the site is visited only when necessary. Other builders appoint representatives to act for them; in this case most of the work must be done on the site, and it must be decided who is to abstract and bill the measurements. All priced bills and variation orders should be carefully examined, and any items that have not been priced, such as labours, which are sometimes included in the price of the material, should be committed to memory. By doing this, much time and trouble spent in useless measuring can often be saved.

85. All the measurements and work done on the site, and very often all the work necessary in the preparation of the variation bill, so far as dimensions or measurements are concerned, are entered in a *dimension*, or *measuring*, *book*. This book is about $7\frac{1}{2}$ inches long by $3\frac{3}{4}$ inches wide and is ruled the same as dimension paper, but has only one set of columns on each page. The dimension book should begin with a heading, which will give the nature of the contract on which the variations occur, the name of the builder, and the name of his representative. The date of each visit should be entered and also the names of all present, including the clerk of works and foreman. When commencing any measurement in connection with a variation order, the number of the order should be entered in the book, and on the side of the variation order should be written the number and page of the measuring book where the work in connection with the order has been entered. Whenever possible, the omissions in connection with an item should follow the additions of that item; these omissions will generally be obtained from the original dimensions and bills of quantities.

Care must be taken that items which have been measured are not also returned day work, and also that the various invoices and receipts are the net amounts paid, so that adjustment can be made on the same lines as the items in the bills of quantities. As far as possible, the order and method of measurement should be those adopted in the original bills of quantities.

86. Form of Accounts.—The form or order of the bill forming the variation accounts will vary considerably as to the amount of information that is required by the employer. Very rarely will it be possible to have a bill of additions and omissions simply in the order of the trades, for generally the work under each variation order has to be kept separate. Of course, the work under each order will be according to the trades. On large accounts, abstracting will be found just as necessary as for the original bills of quantities. Every page of bill and every sheet of abstract should not only have the number of the variation order, but also a plainly written "addition" or "omission." It is a good practice always to write the latter in red ink.

Variations on Mr William Jones' Contract for House at Exborough for Henry Robinson Esqre

Walter Smith Esqre F.R.I.B.A. Architect

September 191-.

Summary.

			Omissions. £	s	d	Additions. £	s	d
V.O 1.	Variation on windows.		97	6	3	114	5	3
V.O 2.	Omission of wall panelling to Hall.		64	3	1	10	1	2
V.O 3.	Variation on bay to Dining Room.		18	5	3	21	2	6
V.O 4.	Variation on ironmongery.		15	1	6	24	19	3
V.O 5.	Variation on glazing.		7	7	5	15	4	5
V.O 6.	Variation on water supply and sanitary fittings.		44	6	4	59	7	5
V.O 7.	Additional fittings and sundries.		—	—	—	24	3	1
V.O 8	Adjustment of P. & and Provisional amounts.		131	16	2	175	18	5
		£	378	6	0	£ 445	1	6
	Deduct Omissions.					378	6	0
	Net Additions.					£ 66	15	6
	Amount of Contract.					2985	0	0
	Total Cost of Building.					£ 3051	15	6
	Less. Cash paid to Builder on account.					2500	0	0
	Amount due to Builder.					£ 551	15	6

FIG. 22

The charges for the preparation of the variation accounts, if to be paid by the builder, should be added at the end of each variation order or other division in the account. Care must be taken that the charges on the omissions are deducted from, and not added to, the total of the omission bill. The total amount for the additions and omissions of each variation order or other division must be carried to a summary, which is prepared on double-ruled bill paper, as shown in Fig. 22.

SCHEDULES OF PRICES

PROCESS OF OPERATION

INTRODUCTION

87. Definition.—The main difference between bills of quantities and *schedules* is that in bills of quantities the amount of material and labour is found first and the rates and prices are affixed to the respective items afterwards. In schedules the rates or prices are arranged first for items that are likely to occur, and then, while the work is progressing and at its completion, the material and labour are measured up as actually executed. The dimension or measuring book is used for these measurements as for variations.

88. Object of Schedules.—Schedules are used instead of bills of quantities when : (*a*) it is desirable to commence a building before an accurate bill of quantities can be prepared ; (*b*) it is necessary to commence a building before the complete scheme is fully thought out ; (*c*) in cases of jobbing work, repairs, etc., which from their character cannot very well be represented by a bill of quantities. Some architects also use schedules in work of the very best class, so that details can be varied to suit the wishes of the employer as the work proceeds. Work executed under a schedule invariably costs more than when quantities are prepared.

89. Different Methods of Schedules.—All schedules must contain a provision for every item that is likely to be required for the particular work to be executed, but they vary with regard to the method by which they are prepared. The three most usual methods are: (*a*) A copy of the schedule is sent to a contractor, who fills in the rate or price per foot, etc. (*b*) Before sending the schedule to the contractor, slightly higher prices or rates than would be considered fair or current are placed opposite each item; the contractor then states for what percentage below these rates he will carry out the work. (*c*) The schedule is similar to the first, but approximate quantities are placed opposite each item. The last method is not common, but is sometimes made use of for large works below the surface of the ground. With such a schedule, it must be clearly stated that the amounts are approximate and no responsibility whatever is accepted for the amounts.

90. Comparison of Schedules.—When more than one contractor is invited to tender for work under a schedule drawn up under the first method just given, it is necessary, after the schedules are returned by the contractors, to prepare a comparison or analysis, to find which is the most favourable tender for the work proposed. It will not be sufficient or correct to add up the whole of the prices of the respective schedules and compare the results. The comparison must be based on the approximate amount that is likely to be required of each of the important items, except in the case of the prices for labour in day work, when there is no other alternative but to add all the rates per hour together and arrive at the average; for instance, bricklayer, 10d.; mason, $10\frac{1}{2}$d.; labourer, $6\frac{1}{2}$d., the average will be $\frac{10 + 10\frac{1}{2} + 6\frac{1}{2}}{3} = 9$d.

91. The amounts of each item taken for the purpose of comparison, while being quite approximate, should not be merely assumed nor entirely for the large items only. Of course, the large items must be considered, but those items of smaller value that will be largely used must also be included. One schedule sometimes appears to be very much more favourable than the

others, because all the main items are slightly lower than the rest; but if the other items are very much higher, it is likely that what appears to be an advantage on the main items will disappear when the other items are taken into consideration. In Fig. 23 is given an arrangement for the comparison of schedules.

COMPARISON OF SCHEDULES

	A				*B*			
		£	s.	d.		£	s.	d.
500 yards excavation and carting .	4/4	108	6	8	4/6	112	10	0
300 yards concrete .	11/-	165	0	0	11/3	168	15	0
30 rods brickwork .	14/15/-	442	10	0	15/-/-	450	0	0
120 feet Portland stone . . .	7/10	47	0	0	8/-	48	0	0
200 feet fir	3/-	30	0	0	2/10	28	6	8
50 squares flooring .	34/-	85	0	0	35/-	87	10	0
200 cwt. steel joists .	9/6	95	0	0	10/-	100	0	0
360 screw bolts . .	1/6	27	0	0	4d.	6	0	0
30 cwt. lead . . .	23/-	34	10	0	21/6	32	5	0
300 yards paint . .	1/4	20	0	0	1/-	15	0	0
500 hours day work .	11d.	22	18	4	9d.	18	15	0
Total . .		£1,077	5	0		£1,067	1	8

FIG. 23

In it, the prices of one contractor *A* are much lower for the excavation, concrete, brickwork, Portland stone, flooring, and steel joists, but when the probable amounts of these are considered with the other items, it is found that the other contractor *B* is the more favourable.

PREPARATION OF SCHEDULES

92. General Outline.—A schedule should contain a complete list of all the items of labour and material likely to be found when the work is measured up. It should be arranged according to trades, and each trade should begin with its preamble, the items following in the order used for bills of quantities.

When there is to be any special method for the measurement of certain items, the method should be clearly described with the items or follow the preambles at the beginning of the trades.

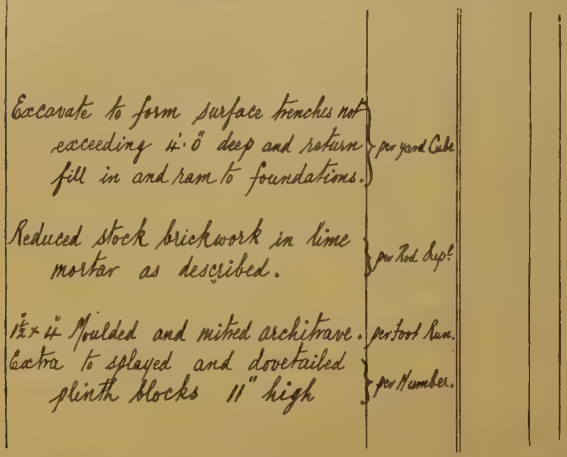

Excavate to form surface trenches not exceeding 4'-0" deep and return fill in and ram to foundations.
per yard Cube
Reduced stock brickwork in lime mortar as described.
per Rod Sup.
1½ × 4" Moulded and mitred architrave.
per foot Run.
Extra to splayed and dovetailed plinth blocks 11" high
per Number.

Fig. 24

The method of entering items in a schedule in which the contractor is to fill in the prices or rates is shown in Fig. 24.

93. When the schedule gives prices for the various items, and the contractor has to state at what percentage below these prices he will carry out the work, then the schedule should contain the

SCHEDULE FOR EXTRAS ON DRAIN PIPES

	Bends	Single Junctions	Double Junctions	
Extra on 4" pipe for .				Each
Extra on 6" pipe for .				,,

Fig. 25

following clause: "The contractor is to examine very carefully the prices given against each of the respective items in this schedule, and to fill up the form of tender at the end stating at what percentage below the prices he is willing to undertake the work. No alteration whatever is to be made to the prices already filled

in, and the percentage must be general on the whole of the schedule." A portion of the schedule must be reserved for day work; this will have to be arranged in fuller detail than for a bill of quantities, especially if the work is of a jobbing nature.

SCHEDULE FOR TEMPLATES

York Stone	9″ × 4½″	9″ × 9″	9″ × 13½″	9″ × 18″	13½″ × 13½″
3″ Tooled templates and building in each					
4″ Ditto					
6″ Ditto					
9″ Ditto					

Fig. 26

SCHEDULE FOR DEAL

Deal		Thickness						
		½″	¾″	1″	1¼″	1½″	1¾″	2″
Wrought one side and fixed	Per foot sup.							
Wrought both sides and fixed	,,							
Add if cross-tongued	,,							
2″ wide and under, wrought	Per foot run							
Ditto once chamfered or beaded	,,							
Ditto twice ditto	,,							
Ditto once moulded	,,							
Ditto twice moulded	,,							
Over 2″ wide and not exceeding 3″ wide wrought	,,							
Ditto once chamfered or beaded	,,							

Fig. 27

Tender.

To
Walter Smith Esqre F.R.I.B.A.
Architect
30 Grays Inn Square
London. W. C.

Sir

-------- willing to Contract for and hereby undertake to execute the several works required to be done in the erection and Completion of a House at Exborough for Henry Robinson Esqre according to the drawings and specification prepared by you and to your entire satisfaction and subject to the various stipulations and conditions given at the prices stated against each of the respective items in the Schedule bound up with this Tender.

As witness ..... hand... this -------- day of --------- 191-

Name _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Address _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

The Employer does not bind himself to accept the lowest or any Tender.

FIG. 28

Tender.

To
Walter Smith Esqre F.R.I.B.A.
Architect
30 Grays Inn Square
London. W. C.

Sir

--------- willing to Contract for and hereby undertake to execute the several works required to be done in the erection and completion of a House at Exborough for Henry Robinson Esqre according to the Drawings and Specification prepared by you and to your entire satisfaction and subject to the various stipulations and conditions given at------ per. Cent. below the prices stated against each of the respective items in the Schedule bound up with this Tender.

As witness------ hand... this_____day of-------- 191-.

Name_____
Address-_____
_____

The Employer does not bind himself to accept the lowest or any Tender.

FIG. 29

94. Preliminaries, Etc. — The items of preliminaries, etc., must all be placed at the beginning of a schedule, but as far as possible these items should be considered as works necessary for carrying out the contract without any special payment. The value of these is taken as part of the expenses which are to be met out of the profits on the measured items. Provision must be made for the contractor to state what profit he requires on all prime-cost sums paid out by him for certain work. This may be done by inserting: "An allowance or addition of per cent. on the prime-cost sums paid out by the contractor for insurance, fees, payment to local authorities, cost of water and gas, stoves, chimneypieces, ironmongery, and for other work carried out by workmen, other than those of the contractor, on the certificate of the architect. In all cases for work executed by other workmen, the allowance or addition must include for the use of scaffolding, temporary protections, casings, and other attendance. The prime cost in all cases is to be interpreted as the amount paid by the contractor after deducting trade allowances, but not the ordinary discount for cash."

95. Excavator and Concretor.—There should be no great difficulty with the items of excavator and concretor. When the excavation is at various depths, the first description should include down to a depth of 6 feet, and then the following item for the remainder: "Add for every 6 feet additional depth beyond the first 6 feet." Where in underpinning, the excavation and concrete is best covered by an item as extra over the ordinary excavation and concrete, for instance, "add if in underpinning."

96. Bricklayer.—The various kinds of brickwork should be arranged as extra over the first general item; for instance, "add for hoisting over 60 feet above the ground," or "add for being in backing to masonry."

97. Drains.—The extras on the drain pipes are best arranged as shown in Fig. 25.

98. Mason.—In the mason's schedule, the method of measurement should be given, especially if there is much stonework in dressings, etc. The items of extra hoisting, scantling lengths,

etc., can be dealt with in the same manner as brickwork. A tabulation like that shown in Fig. 26 may be very useful if there are a number of templates of different sizes.

99. Carpenter and Joiner.—The schedule for the carpenter and joiner must generally follow the arrangement given for these trades in the bills of quantities. A form like that shown in Fig. 27 may be very useful for items of thicknesses per foot superficial and also for running items. Hardwoods can be very often dealt with as a percentage over the price of deal; for instance, "add on the foregoing prices of labour and material in deal for work in Austrian oak per cent." Ironmongery fixed to hardwood can also be dealt with as a percentage over that fixed to deal.

100. Founder and Smith.—The items for the schedule of the founder and smith and other trades must be the same as for a bill of quantities. Often much time and space may be saved by the use of tabulations, as previously shown. Whenever there are many sizes to one description, these items will lend themselves to a treatment by table.

101. Tender.—As for bills of quantities, a form of tender must be prepared for schedules, but it will come at the end and form part of the schedule. In Figs. 28 and 29 are shown two forms of tenders; that shown in Fig. 28 will apply to a schedule drawn up according to the first and last methods in Art. **89**; Fig. 29 is applicable for a schedule drawn up according to the second method in Art. **89**.

QUANTITIES AND ESTIMATING

(PART 4)

APPROXIMATE ESTIMATES

BASIS OF PRICES

INTRODUCTION

1. Important Factors in Approximate Estimating.—Great care must be taken when making an approximate estimate of the value of any given work before erection, because the essential factors depend as much on the value of the work as on the amount of material and labour. The cost of a building will depend to some extent on the shape and position of the site, the size of the building, and whether it has extensive and costly finishings, deep basements and sub-basements, extensive boundary walls and drains, and an exceptional amount of detail in the mason's, joiner's, and plasterer's work.

Large buildings are always cheaper, in proportion, than small ones, because the materials may be bought in larger quantities, the workmen do not interfere with and hinder each other, and all special work, such as doors, windows, mouldings, etc., can be made more cheaply in large quantities. Buildings of two or more stories are cheaper, in proportion, than buildings of only one story, because of the saving in the excavation, roofing, etc. If a site is of an awkward shape or is not easily reached, the cost of delivering the materials and the cost of the labour will be greatly increased. In all cases the work should be treated

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as if it were of a usual character, and at the end an amount or percentage should be added for special contingencies.

2. Methods of Approximate Estimating.—An approximate estimate of the value of the building may be made according to: (*a*) the cost per foot cube, (*b*) the cost per unit of accommodation, and (*c*) by taking rough quantities and approximately pricing the same.

Contracts for the erection of any building should not be arranged on the result of approximate estimates, except, perhaps, in those cases where rough quantities have been prepared, and then only when the drawings and specifications have been so carefully prepared that everything of importance has been either shown on the drawings or described in the specification. Although some builders will give tenders based on these estimates and will sign contracts and carry out the work, trouble nearly always arises by their finding out that work has been done which they had not included in their price. Besides, there are very few, if any, prices on which to base or value the variations that are sure to occur.

APPROXIMATE ESTIMATING BY CUBING

3. Buildings to Which Cubing is Applicable.—Approximate estimating by the method of valuing per foot cube, or **cubing,** may be applied to every kind of building because of its general convenience; moreover, it is the best-known and most usually adopted method. However, it can only be considered a preliminary way of arriving at the probable cost of any proposed building, because of the difficulty of really making true comparisons with buildings already erected. There is also the objection that the solids and voids contained in the building are added together and valued at an average price for both. Yet with some experience and a clear description of the materials and finishings that will be used, a very close estimate of the value of the building can be obtained. This method cannot be used for work of a purely alteration character, for in this work each item must be carefully valued separately. Very often the addition of a new block to an existing building may

be dealt with by the cubing method, and the sundry items in connection with the existing work separately valued and added to the result of the cube.

4. Method of Measurement.—The usual method of finding the number of feet cube in any given building is to multiply the outside length of the building by the outside breadth and the result by the height. The height is measured from the bottom of the footings, that is, the top of the concrete, to half-way up the roof. In houses where there are attic rooms in the roof, it is usual to take the height to three-quarters the way up the roof. The height of buildings which have flat roofs with parapets is taken to at least the top of the parapet. All projections, such as bays, oriels, and porches, and also all outbuildings, are measured by the same method and added to the first calculation, unless these items are to be valued at a different rate than the main building. Chimney stacks, buttresses, and dormers are usually ignored, unless there is an unusual number of them.

EXAMPLE.—What is the number of feet cube in a house 40 feet long and 30 feet wide in the clear between the walls ? The walls are 18 inches thick, the height from the bottom of the footings to the eaves is 21 feet, and the height from the eaves to the ridges is 8 feet. On one side of the building a bay projects 3 feet 6 inches in the clear beyond the main wall, the bay is 10 feet long in the clear, has walls 9 inches thick, and has a flat roof with parapet round ; its height is 12 feet from the bottom of the footings to the top of the parapet.

SOLUTION.—The length of the main building is 40 ft. + (18 in. × 2) = 43 ft. ; the width is 30 ft. + (18 in. × 2) = 33 ft. ; and the height is 21 ft. + (8 ft. ÷ 2) = 25 ft. ; therefore the main building contains 43 ft. × 33 ft. × 25 ft. = 35,475 ft. cube. The length of the bay is 10 ft. + (9 in. × 2) = 11 ft. 6 in. ; the width is 3 ft. 6 in. + 9 in. = 4 ft. 3 in. ; and the height is 12 ft. ; the bay therefore contains 11 ft. 6 in. × 4 ft. 3 in. × 12 ft. = 586 ft. 6 in. cube. The total feet cube in the building is therefore

35,475 ft. + 586 ft. 6 in. = 36,061 ft. 6 in. Ans.

5. Value Per Foot Cube.—After finding the total number of feet cube in a building, it is necessary to find the value per foot to complete the approximate estimate. On the value per foot that is taken depends the success of this method, for the difference of 1d. in the rate makes a big difference in the value

of even an ordinary house. The usual rule is to take the same price as the actual cost of similar buildings which have been erected under similar conditions; but this, in many cases, will be quite impossible owing to the absence of reliable data. For this reason, a record should be kept of the number of cubic feet and the cost of all buildings for which bills of quantities have been prepared. This record can then be used as a guide as to the value of any work contemplated, the difference in conditions, etc., being met by a percentage one way or another on the result.

TABLE I

COST PER FOOT CUBE OF DOMESTIC BUILDINGS

Class of Building	Cost Pence
Labourers' cottages . . .	4 to 5
Cheap dwelling houses . .	5
Suburban houses and villas .	6 to 9
Good country houses . . .	8 to 10
Main building of first-class country mansions . . .	10 to 15
Attached offices, or servants' department, of first-class country mansions . . .	6 to 10
Stables and farm offices . .	7 to 11
Large town houses . . .	12 to 18

6. Most buildings can be classified under one of three divisions: domestic, business, public. In Tables I to III are given the cost per foot cube of various kinds of buildings which would come under these headings. The prices are those of buildings erected in various parts of London and the provinces, but they can only at the best be suggestive; local and other conditions must always

TABLE II

COST PER FOOT CUBE OF BUSINESS PREMISES

Class of Building	Cost Pence
Farm buildings	$3\frac{1}{2}$ to $4\frac{1}{2}$
Bonded stores	$3\frac{1}{2}$ to $4\frac{1}{2}$
Large factories and workshops	$4\frac{1}{2}$ to 7
Warehouses of plain character	$5\frac{1}{2}$ to 9
Breweries	4 to 6
Banks	9 to 15
First-class hotels	16 to 18
Second-class hotels . . .	10 to 16

be taken into consideration. In Table IV is given a list of the actual prices per foot cube of certain well-known buildings which may be useful for the purpose of comparison.

TABLE III

COST PER FOOT CUBE OF PUBLIC BUILDINGS

Class of Building	Cost Pence
Schools	5 to 11
Workhouses	6 to 10
Lunatic asylums and similar buildings	7 to 10
Cottage hospitals	7 to 10
General hospitals, including administrative buildings	8 to 12
Infectious hospitals, including administrative buildings	10 to 13
Public baths, including machinery and appliances	10 to 14
Public halls and libraries	7 to 14
Municipal buildings, town halls, and other public buildings of the first class	8 to 16
Chapels, including seating	5 to 8
Churches, including tower and seating	6 to 12

7. Sometimes it may be necessary to adopt a different price per foot cube for the various parts of a proposed building; for instance, a sanitary block, with a lot of expensive work, which is in connection with what is otherwise a very plain building, or the attached offices or servants' department to a first-class country mansion, which are not worth nearly as much as the main building generally. However, it is far more convenient, whenever possible, to adopt a uniform rate throughout. Boundary walls, laying out of grounds, exceptionable drain work, and such items are best dealt with separately and an amount added to the result of the cube.

EXAMPLE.—Make an approximate estimate of the cost of erecting a house which has 36,100 feet cube, taking the value per foot cube at $8\frac{1}{2}$d.

The drains being rather exceptionable, an additional £30 must be included for them and £50 for contingencies.

TABLE IV

COST PER FOOT CUBE OF CERTAIN BUILDINGS

Building	Cost Pence
Macroy Memorial Presbyterian Church, Belfast	$5\frac{1}{2}$
Town Hall, Enniskillen, Co. Fermanagh	7
General Post Office, London	$8\frac{1}{2}$
St. Thomas's Hospital, London	9
General Hospital, Birmingham	9
Manchester Assize Courts	$9\frac{1}{2}$
Hotel Great Central, Marylebone, London	$10\frac{1}{2}$
Bow Street Police Court, London	11
Royal Exchange, London	11
Foreign Office, London	13
Town Hall, Portsmouth	14
Holborn Viaduct Hotel, London	16
British Museum, London	18
Hotel Victoria, Northumberland Avenue, London	18
Houses of Parliament, London	30

SOLUTION.—Since the cost of the building at 1d. per ft. cube is 36,100 × 1d. = £150 8s. 4d., the cost at $8\frac{1}{2}$d. per ft. cube is £150 8s. 4d. × $8\frac{1}{2}$ = £1,278 10s. 10d., or, in round figures, £1,280. Adding to this the amounts to be included for the drains and contingencies, the cost of the house will be

£1,280 + £30 + £50 = £1,360. Ans.

APPROXIMATE ESTIMATING ACCORDING TO UNIT OF ACCOMMODATION

8. The method of approximate estimating according to the unit of accommodation is only a rough-and-ready way, and should be used only as a check on some accurate method. It is

largely used to determine the rough cost of a proposed building before the plans are prepared, and is applicable to such buildings as churches, hospitals, schools, stables, workhouses, asylums, etc. Most buildings of this class require a certain amount of administrative accommodations whether the buildings are large or small. These administrative accommodations consist of separate buildings, or parts of the main building, for laundry, boiler and engine

TABLE V

COST PER UNIT OF ACCOMMODATION

Class of Building	Cost Pounds
Labourers' cottages	45 to 65 per room
Suburban houses and villas	70 to 120 per room
First-class country mansions	200 per room
Stables	50 to 100 per stall
Schools	10 to 30 per scholar
Workhouses	100 to 200 per inmate
Lunatic asylums	200 to 300 per inmate
Cottage hospitals	200 to 300 per bed
General hospitals, including administrative buildings	250 to 400 per bed
Infectious hospitals, including administrative buildings	300 to 550 per bed
Public halls	3 to 5 per sitting
Chapels, including seating	5 to 7 per sitting
Churches, including tower and seating	9 to 14 per sitting

house, bakery, quarters for master and matron, kitchen, dining hall, nurses' quarters, lodge, etc. As they vary considerably, they make a great difference in the cost per unit of accommodation. For instance, in St. Thomas's Hospital, London, one pavilion, without administrative buildings, cost £250 per bed; but when the whole building, which consists of eight blocks and administrative buildings, is taken into consideration, the cost is £650 per bed.

9. In Table V is given the cost per unit of various kinds of buildings. While these prices can only be suggestive, they are very useful for comparison, though there are so many important factors to be taken into consideration that comparison between other buildings is at times almost impossible.

ESTIMATING BY ROUGH QUANTITIES AND APPROXIMATE PRICES

10. Approximate estimates obtained by preparing rough quantities and approximately pricing same are the most accurate, but a longer time is required than with other methods. Still, whenever possible, the main items, like brickwork, floors, roofs, etc., should always be treated in this way even if there is not time to treat the whole. As a rule, when preparing approximate estimates by this method, the more costly items are measured as for bills of quantities, and an allowance is made in their price for all the minor ones. As this work must often be done from sketch plans and scanty information, the measurements are not taken quite as accurately as for bills of quantities, and the scaling is considered sufficiently accurate when scaled to the nearest 6 inches or foot.

Dimension paper is used for these rough quantities, but only one set of columns should be used for the measurements and descriptions, the other columns being left free for the pricing. The items that need collecting can either be abstracted in the ordinary way or the collections made on separate sheets of dimension paper, which, at completion, are paged in at the end. It is not usual to prepare bills for these approximate estimates.

11. **Approximate Prices.**—The following prices for the important items in each of the respective trades are, of course, only approximate. They are based, as far as possible, on London prices given in fair competition; for the provinces they will be subject to from 5 to 20 per cent. deduction, according to the cost of labour in the district and other local conditions. Any old priced schedule or bills of quantities for work in the neighbourhood of the proposed new building is exceedingly useful for making an approximation from rough quantities.

12. Excavation.—All excavation must be roughly measured, the excavation over the surface being taken with the floors. The excavation to the basement and trenches can be priced together. That which is to be returned, filled, and rammed will cost 2s. per yard cube ; that which is to be carted away will cost 5s. per yard cube. Trenches that are partly returned and partly carted away, assuming that one-third is returned and two-thirds carted away, can be priced at 4s. per yard cube. These prices will depend to a great extent on whether or not a shoot for the surplus material is within a short distance. Planking and strutting and keeping clear of water, if of the usual character, can be considered as having been included in the prices of the excavation.

13. Concrete.—All concrete in foundations must be roughly measured. Lime concrete may be priced at 10s. per yard cube and cement concrete at 14s. per yard cube.

14. Brickwork.—All the brickwork must be roughly measured and collected, deductions being made for doors and windows ; the price should include all cuttings, external brick facing, rough and fair arches, damp-proof course, and sundry items. Brickwork that is to be built in lime mortar may be priced at £18 per rod superficial reduced, or £1 12s. per yard cube ; brickwork that is to be built in cement mortar may be priced at £20 per rod superficial reduced, or £1 15s. 6d. per yard cube.

15. Fireplaces.—A provision should be included for stoves, ranges, and chimneypieces plus from 10 to 15 per cent. for profit, etc. All fireplace openings should be numbered and priced at £2 each, which will include all the sundry work in connection with each opening.

16. Drains.—The total length of drain pipes should be collected, each size being kept separate. The 4-inch stoneware pipe may be priced at 1s. 9d. per foot run ; 6-inch stoneware pipe, at 2s. per foot run ; 4-inch cast-iron pipe, at 2s. 3d. per foot run ; 6-inch cast-iron pipe, at 3s. 6d. per foot run. These prices will include digging, concrete, pipes, bends, etc., for stoneware pipes, but it will not include concrete for the cast-iron

pipes, only brick bearers. About £10 should be allowed for each connection to the sewer. All stoneware gullies, grease traps, etc., should be numbered and priced at £1 each. Fresh-air inlets will cost about £1 each unless the length of iron pipe is exceptionable. The cost of manholes will vary according to the depth. Those of ordinary size with plain iron covers and not exceeding 2 feet deep will cost about £3 10s. ; where over 2 feet deep, £1 should be allowed for each additional foot in depth.

17. Masonry.—The stonework in dressings, etc., should be measured in the ordinary way, but the foot cube must include all labour of every description. If the building has a stone front and time is rather short, an average for the bed of the stone over the whole face can sometimes be arranged. In such a case, the whole width of the front should be supered by the height and cubed by the average on bed, all openings being ignored in this measurement. A fairly plain stone building will average about 12 inches on bed, but where there are heavy cornices or dressings this may not be sufficient. The actual price per foot cube must be reduced, so as to allow for the value of the brickwork that is displaced by the stone. Taking this allowance into consideration, Portland stone should be priced about 11s. 6d. per foot cube and Bath stone about 8s. per foot cube.

Steps should be taken with the doors and sills should be taken with the windows. York stone coping to parapet walls must have the lengths collected. The price for 12 inches wide by 3 inches high, including all extra labour at ends, etc., will be about 2s. 3d. ; for 18 inches wide, it will be about 3s.

18. Floors.—All floors must be roughly measured per foot superficial, all voids being ignored. Solid floors, the price of which must include surface excavation, bed of broken brick, bed of concrete, and cement paving, will cost from 5s. to 7s. 6d. per yard superficial. Tile paving will cost from 12s. to 15s. per yard superficial. Hollow floors at the lowest level, the price of which must include surface excavation, bed of broken brick, bed of concrete, sleeper walls, plates, ground joists, and flooring, will cost about £4 10s. per square of 100 superficial feet. Hollow

upper floors, the price of which must include the wall plates, floor joists, strutting, flooring, and the plaster ceiling under, will cost about £4 5s. per square of 100 superficial feet.

19. Partitions.—All partitions should be roughly measured by taking the width by the height, all openings being ignored. The price of stud partitions, including the studding and the plastering on both sides, is from £3 to £3 5s. per square of 100 superficial feet. Brick partitions $4\frac{1}{2}$ inches thick, plastered on both sides, will cost about 9d. per foot superficial. Patent partitions with two coats of plastering on both sides will vary from 4s. to 6s. per yard superficial.

20. Roofs. — Roof purlins and trusses should be roughly measured and the total number of cubic feet found in the ordinary way; they will cost 3s. 6d. per foot cube, and 4s. 6d. per foot cube if wrought. The superficial quantity of roof covering, including the rafters, should be roughly measured by taking the length on plan by that on the slope; the prices will be about as follows: Rafters, battens, and countess slating, £3 15s. per square of 100 feet superficial; rafters, battens, and plain red tiling, £4 per square of 100 feet superficial. If roofs are to be covered with $\frac{3}{4}$-inch rough boarding and roofing felt, 25s. per square should be added. These prices include all cuttings, hips, valleys, and ridge tiles. An additional sum must be included for any dormers, cupolas, etc., for the cost of these varies so much that it is impossible to state a price.

21. Lead Flats.—The lead flats must be measured per foot superficial. The price will have to include for the joists, boarding, furrings, rolls, lead covering, flashings, plaster ceiling under, and all minor items. If 6-pound lead is used for the flats and 5-pound lead for the flashings, the price will be about 3s. per foot superficial; 3d. to 4d. per foot should be added if the flat is covered with 7-pound lead.

22. Windows and Doors.—The deduction for windows and doors will have already been made. Windows should be measured per foot superficial to include everything complete; they

will cost from 3s. to 4s. 6d. per foot superficial according to their general finish. The doors should be collected and priced at from £2 15s. to £4 each, complete, according to their finish. Cheap doors will cost from £1 10s. to £2 each. Fanlights and borrowed lights should be collected and priced at from £1 to £2 each. The deductions for plastering are allowed for in the price of the doors, windows, etc.

23. Internal Finishings.—The lengths for all skirtings should be collected and the price must include all mitres and ends. All deductions for doors and fires should be ignored. An average price of 9d. will pay for all the general kinds of moulded skirtings. All plastered ceilings, including those to the soffit of flats, have been taken, but those to the top stories have not. These should be roughly measured and priced at £1 15s. to £2 per square of 100 superficial feet, including the ceiling joists. The plastering on all partitions is taken with the partition, but the plastering on all brick walls, except $4\frac{1}{2}$-inch brick partitions, must be taken separately. This should be roughly measured and priced at 1s. 3d. to 1s. 6d. per yard superficial, including the distempering. The lengths of all cornices should be collected ; this work will cost about $1\frac{1}{2}$d. per inch of girth, including all mitres, bracketing, etc.

24. Staircases. — Time will not usually permit of wooden staircases being measured in the ordinary way, so that a price per step must be taken to include everything. An ordinary deal staircase about 3 feet wide with a hardwood polished hand rail should be valued at about 12s. 6d. per step, while a wider staircase with winders, rather elaborate newels, balusters, and strings, etc., will cost as much as £1 5s. per step.

25. Fittings.—The lengths of all shelving should be roughly measured and priced at from 6d. to 9d. per foot run, including all bearers, etc. ; kitchen dressers can be taken at from 12s. to 15s. per foot run. Other fittings must be measured in the usual way ; but generally at the time when approximate estimates are required very little has been decided concerning fittings, so that the safest course will be to include a lump sum.

26. Founder and Smith.—The lengths of all eaves gutters should be collected, and the price should include all outlets, ends, angles, etc.; they will cost from 9d. to 1s. 6d. per foot run according to size. All rain-pipe heads should be collected; they will cost from 7s. 6d. to 17s. 6d. each. Rain pipes will cost from 1s. to 1s. 3d. per foot run, including all bends, etc. Cast iron in columns, etc., must be measured and weighted out in the usual way; they will cost 13s. per hundredweight, and the patterns about 15s. each. Items of wrought iron will vary in value from 2½d. to 4½d. per pound. Steelwork must be measured in the ordinary way and the total weight found. Where only steel joists are used, they will cost about 15s. per hundredweight; but where there is riveted work as well, an average price of £1 per hundredweight should be allowed. These prices will include for connections, cleats, bolts, etc. A special estimate for steelwork from a manufacturer will be exceedingly useful, but from 10 to 15 per cent. should be added to it for profit.

27. External Plumber.—The lead covering to flats, if any, will have been taken with the flats, but the lead covering of hips, ridges, gutters, valleys, flashings, soakers, etc., must be approximately measured and the total weight found. The cost of lead fluctuates considerably, but £1 5s. to £1 10s. per hundredweight, including all labours, will generally be sufficient to allow for this item.

28. Internal Plumber and Sanitary Engineer.—There is great difficulty in approximating the cost of internal plumbing, because, in all probability, nothing will have been decided or shown on the sketch plans, and because there is a great difference in the cost of the different kinds of fittings which may be chosen by the client. Therefore the following prices can only be considered as very approximate, but they will pay for the ordinary class of good work, but for nothing of an elaborate nature. The storage cisterns should be numbered and priced at about 8d. per gallon, which will include the casing. The lengths of lead pipe to the cisterns, and from the cisterns to the several fittings, should be collected; they will cost from 9d. to 1s. 6d. per foot

run according to the size. The connections to the main will cost about £5 each. Soil and ventilating pipes should be collected and priced at 2s. 6d. per foot when of iron and 3s. 6d. per foot when of lead. All the fittings should be collected ; water-closets, with seats, flushing cisterns, flushing pipes, brackets, connections to drain or soil pipe, etc., complete, will cost from £4 to £10 each ; lavatory basins, including waste pipe and trap, etc., complete, will cost from £2 10s. to £6 per basin ; ordinary sinks, including waste and trap, will cost from £2 5s. to £4 each ; baths complete, including waste, will cost from £8 to £15 each.

29. Gas, Bells, Etc.—Gas-fitting is not usually measured for the purpose of approximate estimating, but the points are counted up and priced at from 10s. to £1 each. The fittings are either priced from a trade list or a sum is provided to cover their cost. All bells should be counted ; their price varies from 10s. to £1 per pull. A provisional sum should be included for hot-water work and electric lighting ; it should include a profit of 10 to 15 per cent. The wiring only for electric lights costs from £1 to £1 10s. per point.

30. Glazing and Painting.—Most of the glazing and painting will have been included in the foregoing items, but for sundry items add about 2 per cent. to the total of the approximate estimate up to this point.

31. Paperhanging. — The wallpaper must be roughly measured and the number of pieces of each value found. The trade discount on wallpapers is about 33 per cent., but 9d. to 1s. per piece added to the list price will pay for the profit, preparing the walls, and hanging.

32. Preliminaries.—The allowance that must be made for preliminaries should be placed at the end as a percentage on the total. Unless of an exceptional character, 1 to $2\frac{1}{2}$ per cent. on the total will meet the general preliminary items. In addition to this, from $\frac{1}{4}$ to $\frac{1}{2}$ per cent. must be allowed for water, and from $\frac{1}{3}$ to $\frac{1}{2}$ per cent. for insurance against fire and workmen's compensation.

PRICING

GENERAL OUTLINE

INTRODUCTION

33. Importance of Pricing.—Pricing, or estimating, is the most important part of a builder's business, for little work is now given out before its cost is ascertained. Though a builder may be a keen buyer, he cannot successfully carry on his work unless he can determine the value of the materials when worked and fixed in any required position.

When pricing, a builder should have a collection of the latest trade circulars and catalogues, with the trade discount for each. He should know the cost of the principal articles in each trade, the railway and canal rates, and the terms of the various merchants with regard to breakage of articles in transit, deficiencies, packing, delivery, payments, discounts, special quotations, etc. He should also keep informed of the market prices of all principal building materials, and also the cost of labour in the various trades to be employed.

34. Basis of Prices.—There are three main factors which form the basis of all prices: *cost of material*, *cost of labour*, and *profit*. Each of these must be carefully considered before any price is affixed to an item. The cost of material can only be found by getting quotations from the several merchants or by knowing the current prices of the materials required; to the actual cost must be added, if necessary, the cartage from the merchant to the builder's yard or shop or direct to the building, with the attendant labour on same. An allowance must also be made for the waste on the material in converting to the scantlings and lengths, etc., required in the work.

35. Another point which must be kept in mind is the possible fluctuation in the value of materials during the progress of the work. If the value falls, a greater profit will result, but a rise in value may entail a loss. For instance, lead may be very cheap when an estimate is prepared, but it may rise considerably before the work has progressed sufficiently for the lead to be bought. To avoid loss by this fluctuation, many builders enter into an agreement with their merchants, directly their tender is accepted, to supply the various materials required for the building at an agreed rate ; needless to state, this is not done for materials which at the time are especially high in price.

36. Labour. — The cost of labour includes the preparation of the material at the bench or workshop and also the fixing in position in the building ; it must also include, in a minor degree, the cartage to the job of the material from the builder's yard or shop, with the attendant labour on same. Also, an allowance must be made for scaffolding, either under labour or under profit. The cost of labour is a more important factor than the cost of material, as so much depends on the workmen, which must always be considered as a speculative item. Idle, careless, and indifferent workmen always mean a loss of profit to the builder, and on small work will very frequently make the difference between a profit and a loss on the whole contract.

37. In Table VI are given the average current rates of wages per hour paid to the several workmen in London ; in Table VII are given the rates of wages and hours of labour within a radius of 20 miles of Charing Cross that are recognized by the London County Council. These rates vary considerably throughout the British Isles, but it will generally be easy to obtain the current rate of wages in any locality by making inquiries of any builder settled in the neighbourhood. For work that must be done in a very short time, overtime will add considerably to the total cost of labour. In London, the general rule is time and a quarter from leaving-off time up till 8 p.m. ; time and a half from 8 to 10 p.m. ; and double time after 10 p.m. On Saturdays, time and a half is allowed from noon up to 4 p.m., and double time after 4 p.m. and on Sundays. Also, on the night gangs, an

additional 1d. per hour is paid to all workmen and ½d. to labourers; Scotch derrick drivers receive 9½d. an hour, steam navvy and grab drivers 9d. an hour, drivers of steam cranes and travellers 8d. an hour, locomotive drivers 8½d. an hour,

TABLE VI

AVERAGE CURRENT RATE OF WAGES IN LONDON

Trade	Wages Per Hour Pence	Trade	Wages Per Hour Pence
Excavator, navvy, or mudman	7	Plasterer	11
Scaffolder	7½	Plumber	11
Bricklayer	10½	Coppersmith	10½
Mason	10½	Zincworker	10½
Tiler, slater, or slatemason	10 or 10½	Glazier, painter, or paperhanger	8½ to 10
Carpenter or joiner	10½	Labourer or mate working with any trade	7
Smith, bellhanger, or gas-fitter	10 or 10½		

stationary-engine drivers 8d. an hour, and portable-engine drivers 7½d. an hour. Carmen driving one horse receive 26s. a week, and those driving two horses 28s. a week. Asphalt spreaders receive from 6s. to 6s. 6d. a day and the potmen and labourers 5s. a day.

38. Profit.—The term **profit** may be divided into two parts: profit on the builder's cash outlay, and establishment charges; both parts must enter into every calculation. As to what may be considered a fair profit on the builder's cash outlay can only be settled by each builder. Many contracts are carried out for very little, if any, profit, and in some cases they have resulted in considerable loss; there is usually less profit made on work which has been won in an open competition than on work tendered for privately. As a rule, the profit on the outlay should not be less than 10 per cent. On large work 7½ per cent. is

TABLE VII

WAGES AND HOURS OF LABOUR RECOGNIZED BY THE LONDON COUNTY COUNCIL

Trade	Rate of Pay Per Hour Pence	Hours of Labour Per Week		
		Summer	13 Weeks After Second Monday in November	
			First 10 Weeks	Last 3 Weeks
Carpenters	10½	50	44	44
Joiners	10½	50	44	44
Bricklayers	10½	50	44	44
Bricklayers cutting and setting gauged work	11½	50	44	44
Masons	10½	50	44	44
Masons fixing	11¼	50	44	44
Masons on granite work	11¼	50	44	44
Smiths, fitters, gas-fitters, etc.	9 to 10	50	44	44
Plasterers	11	50	44	44
Plumbers	11	50	41½	44
Plumbers' mates	7	50	41½	44

Trade	Rate of Pay Per Hour Pence	Hours of Labour Per Week		
		Summer	12 Weeks After Second Monday in November	
			3 Weeks at Each End of Period	6 Middle Weeks
Painters and glaziers	8½	50	47	44
Timbermen	7½ to 8	50	47	44
Scaffolders	7½	50	47	44
Labourers and navvies	7	50	47	44
Granite-sett paviours	10	56½	50½	48
Wood-block paviours	9	56½	50½	48
Paviours' labourers	7	56½	50½	48
Hot-water engineers	9½	50	47	44
Zinc workers	9½	50	47	44
Bellhangers	9½	50	47	44
Paperhangers	9	50	47	44
French polishers	9	50	47	44
Stablemen	6			

satisfactory, but on small work, whenever possible, 15 per cent. should be the minimum.

39. Establishment charges consist of office expenses, including the salaries of clerks, etc., rent of premises, lighting and water, depreciation of machinery and plant, supervision by foreman and others of all work carried out, insurance of workmen, and interest on capital. To a builder having a large business, with very costly workshops and machinery, these charges become a very important factor and must be seriously considered and allowed for in pricing ; but to the builder having only a small office or workshop these charges are not of very much importance, and can almost be considered in the same category as profit. It is therefore difficult to decide just how much should be allowed for these charges and at the same time not make them so excessive as to prevent the builder obtaining work in competition with other builders. They are generally considered to work out between $2\frac{1}{2}$ and 5 per cent. on the total cost of material and labour, but some consider that $7\frac{1}{2}$ per cent. is necessary to meet them.

40. In pricing work contained in a bill of quantities where all the incidental items have been priced in the preliminary bill, if the work can be secured by adding 15 per cent. to the estimated prime cost of all materials the builder should be satisfied. This percentage should be looked on as 10 per cent. profit on the cash outlay and 5 per cent. for establishment charges. On large work this percentage may be reduced, but for very small work which needs the constant supervision of an experienced foreman it may have to be increased.

41. Conditions That Influence Prices.—In addition to the main factors of material, labour, and profit, the price of work is greatly influenced by the capability of the workmen and foreman, the amount of machinery used, travelling and other expenses necessary, the position and shape of the site, and the conditions under which the work must be done. There is apt to be considerable difference between the quantity of work a man can or is supposed to do in a given time and the quantity that he actually does. Builders who have been workmen, when

pricing an item, are apt to base their price on the time it would take them to do it and not on the time it will take the workmen to do it.

Unless the foreman is capable, much time will be wasted through the men being in each other's way, by materials not being on the job when required because they were not ordered sufficiently early, or being on the job have not been brought to the position on the work where they are to be used. Bad management in the working of the job throughout will cause a waste of time at every stage of the work.

42. The amount and the kind of machinery used in the workshops and yards of the builder must, of course, greatly influence the cost of the material worked there. While an up-to-date stonemason's yard and smith's shop and an electrically equipped joiner's shop cost more for maintenance, they turn out work at a much lower cost than those that are without any machinery or time-saving appliances.

Although work in the provinces may be carried out by local labour from 5 to 20 per cent. less than in London and some of the large towns, it must be remembered that all workmen who are sent from the shop or job, including those sent from the towns into the country, must be paid an allowance for expenses, usually about 6d. per day, and also for travelling expenses, time spent in travelling, and lodging money.

A very irregularly shaped site entails a great amount of waste in cutting to irregular angles, while the lack of sufficient storage for materials may mean additional cartage. The position of the site and its approach may entail a great amount of labour in handling the materials before they can be got to the positions required.

43. The conditions under which the work must be executed are sometimes so stringent that the cost is greatly increased. For instance, alterations and additions to private residences, hotels, shops, schools, etc., which must be carried on while the premises are in occupation or while the business or school is carried on during the day, will always cause much extra labour, not only in constantly clearing up rubbish and debris, but also

in not being able to execute the work continuously owing to its not being convenient to the tenants. Work done contemporaneously with other work, for instance, alterations and jobbing work, cannot be done at the same price as a new building. A new plumbing and drainage scheme to an old building cannot be executed as cheaply as the same scheme to a new building; and painting and decoration of an existing building will cost very much more than the same work to a new one.

44. Comparison Between Labour and Material.—Several tables have been prepared giving the actual results of comparisons

TABLE VIII

PROPORTION OF LABOUR TO MATERIALS

Trade	Labour Per Cent.	Materials Per Cent.	Trade	Labour Per Cent.	Materials Per Cent.
Excavator .	90	10	Founder and		
Concretor . .	17	83	smith . .	20	80
Bricklayer .	30	70	Gas-fitter . .	75	25
Drainlayer .	34	66	Plumber . .	25	75
Mason . . .	50	50	Plasterer . .	65	35
Slater or tiler.	25	75	Glazier . .	15	85
Carpenter . .	35	65	Painter . .	50	50
Joiner and			Paperhanger .	30	70
ironmonger	60	40			

between the value of labour and that of materials. For houses of a very good class, these tables show that the labour averages about 42 per cent. and the materials 58 per cent. of the total cost. In Table VIII is given a very fair average of the proportional value of the labour compared to the materials in the different trades; this table may be useful for purposes of reference when finding the total prime cost of work carried out.

45. Comparison Between the Value of Trades.—The percentage of the cost of the work in each trade, compared with the total cost of a building, is sometimes useful, but such a comparison can only be approximate, because the cost of work in

every trade varies with every change of design and class of building. In Table IX is given two typical cases of the approximate percentage of the cost of work in each trade compared with the total cost of a building.

TABLE IX

APPROXIMATE PERCENTAGE OF TRADES TO TOTAL COST OF BUILDINGS

Trade	General Building Per Cent.	House Building Per Cent.
Preliminaries, excavator, and concretor	7	9
Bricklayer	24	28
Drainlayer	1	
Mason	$1\frac{1}{2}$	3
Slater or tiler	5	5
Carpenter	$9\frac{1}{2}$	30
Joiner and ironmonger	30	
Founder and smith and gas-fitter	6	8
Plumber	7	5
Plasterer	5	7
Glazier, painter, and paperhanger	4	5

46. Common Errors.—In pricing bills of quantities, errors are likely to occur through both carelessness and haste, owing to the time to complete the work being short. These errors are sometimes very serious; therefore precautions should always be taken, both to avoid and to discover any that may have been made before it is too late. When completed, all prices should be carefully looked through, when errors will generally be noticed. When considerable pricing must be done in a very short time, there is an inclination not to read the preambles to the different trades. Although generally they contain only the descriptions of materials and the method of workmanship, they sometimes contain items that require pricing or notes that will influence the prices of the items following. Also, very often the form

of contract, drawings, etc., remain unexamined and the site unvisited, which is very undesirable.

47. Among the most common errors are: Items in the bills without any rates attached; sundry items of labour are often left unpriced purposely, as the estimator has considered that they are allowed for in the other prices, but it must be noted that there are no items of importance which are without rates attached. Items that have rates may not agree with other rates; for instance, circular work may be given at a lower price than straight work, or brickwork in cement may be priced at the same rate as brickwork extra only in cement. Items measured in yards may be priced at the rate of a foot, or items measured in feet may be priced at the rate of a yard. These errors can only be guarded against by carefully noting each item, before pricing, whether it is in feet or yards. Another source of error is the method used in writing down the rates against the different items when parts of a penny are employed. A farthing, halfpenny, and three farthings should always be written $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and not $^1/_4$, $^1/_2$, $^3/_4$, for the latter can easily be mistaken for 1s. 4d., 1s. 2d., or 3s. 4d.

EXAMPLES OF PRICING

INTRODUCTION

48. Scope of Examples.—In the following examples of pricing it is not intended to give all the prices that are likely to occur in quantities for even the smallest of work, but rather to give the leading items in each trade. These will show how the prices are compiled, and so give the idea for the calculating or building up of any prices that may be required in practical experience, together with points or tables of importance that have any bearing on the value of work. The prices given are not meant to be standard rates, for, since the cost of material, labour, etc., varies in every locality, it is impossible to give a standard that would be of any practical use. In these examples, 15 per cent. has been added for profit, but very few jobs of any

size are won in competition on which so much profit has been added.

Probably the most difficult items that the estimator must price are those usually found under the heading of preliminaries. Many of the items there found cannot be priced in themselves, but the information contained in them will influence most of the prices throughout the bills; these items, therefore, may be termed *items of general information*, and must be kept in mind throughout the pricing.

PRELIMINARIES

49. Notices and Fees.—The builder must generally give all notices to local and other authorities, deposit all necessary plans, and pay all fees legally demandable, including those to the district surveyor, when necessary. Where a building is subject to the supervision of the district surveyor, the fees to be paid are settled under a schedule given in the London Building Act. The local by-laws, which give all necessary information with regard to depositing plans, etc., can always be obtained on application at the borough surveyor's office, where information can also be obtained of any fees that must be paid by the builder. The estimator must add to these amounts for profit as he considers necessary.

50. Hoarding.—The cost of hoarding and protection for the public, where work is to be done next a public thoroughfare, the protection of adjoining property, and such items will vary with the locality and the nature of the proposed work. The value of these items is best judged after a visit to the site. The material for hoarding, screens, etc., is known as *use and waste;* that is, it is material that can be used more than once for the same or a similar purpose. Its price, therefore, may be found by taking the cost of material, cartage to the site, erection, taking down at completion, and carting away at completion, less the value of the old material, and plus profit. Certain fees must generally be paid for the licence for the hoarding at so much per foot run per month, while an additional fee is payable, in many cases, if the hoarding is to be used for advertising

purposes. Against this is the rent of the hoarding when let for advertising purposes to bill posters; this, of course, varies considerably, according to the position.

51. Scaffolding.—The item for scaffolding, tools, tackle, etc., is not generally priced in the preliminary bill. Their value is taken into consideration when finding the cost of brickwork, but otherwise these items are considered as part of the builder's plant, and are allowed for under the heading of profit as being part of the establishment charges, as are also sheds for workmen and materials, foreman's office, etc. Scaffolding and plant can always be obtained on hire, but most builders prefer to possess their own, except in special circumstances. In certain places, fees must be paid for licences for scaffolds, which, when necessary, must be allowed for.

52. Foreman.—It is necessary to allow for the wages of the foreman either under the head of profit, as being part of the establishment charges, or in the prices of the general items. Some builders prefer to enter a separate amount for his wages based on the time it will take to complete the work.

53. Clerk of Works' Office.—A clerk of works is the representative of the employer and acts under the architect; he is appointed and paid by the employer. The builder, however, has to provide an office for his use, together with the requisite firing, lighting, and attendance. This office is either a temporary wooden structure erected on the site or a portable office kept by the builder for this purpose. Its cost will depend very much on whether any definite size is stated and what fittings are required within it. Any amount from £10 to £30, or even more, can be expended on this office. An allowance of about 6d. per day should be made for firing during the winter months.

54. Watching and Lighting.—The builder must always allow for all watching and lighting necessary for the work. All the work and materials are at the builder's risk, so that he has to decide whether or not a watchman is necessary during non-working hours to prevent the theft of materials, etc. Whenever

a watchman must be employed, an allowance has to be made for his pay and the necessary lighting and firing ; this allowance is based on the time it will take to complete the work. When artificial light will be necessary to carry out any work, this item must be allowed for, but each job must be considered on its own merits and a sufficient sum included to cover the cost.

55. Attendance.—Attendance of each trade on all other trades, except to such special trades as gas-fitter, electrician, etc., which are usually mentioned separately, is a difficult item to price, but £5 is generally considered the minimum, while £1 per £1,000 of work should be allowed for large buildings. This item is meant to cover the cost of workmen in one trade aiding the workmen in another trade just when they require it. In the North of England, where the system of separate contracts for each trade is the custom, this item is worth considerably more than this sum to the individual contractors.

56. Water.—The supply of all water that is required for the work has generally to be arranged and paid for by the builder. The actual cost of the water will be according to the scale of the particular water company interested, and can always be obtained on application at the company's office. In addition, there is generally a fee for opening up the ground and connection to the main ; this latter must only be taken into consideration when it is necessary to have this connection in addition to the one usually necessary for the water supply to the new building. The price is based on the cost of water plus the opening up of ground, connection, lengths of pipe with unions and valves, and profit. In country places, allowance may have to be made for the use of a pump and hose or even for the digging of a well ; in such cases a sufficient sum must be included to meet the cost of the work.

57. Insurance.—The builder has generally to include for the insurance of the building against fire. The usual premium for buildings in the course of erection varies from 1s. 3d. per £100 of value for 3 months up to 2s. 6d. for 12 months ; to these charges the estimator must add for profit.

58. Clearing Away Rubbish.—The clearing away of all rubbish, dirt, and superfluous material from time to time as it accumulates, and at completion, and the item of leaving the premises clean, tidy, and fit for occupation, are very similar to the item for attendance on all trades. They should be priced in a similar way, except that on a small job £2 or £3 may be sufficient.

59. Defects or Maintenance.—The value of the item for making good defects or maintaining the building for a certain number of months after completion depends, to a very great extent, on the builder, or rather on his foreman and workmen. If the work has been executed with good sound material, the workmanship has been good, and all pipes and fittings have been carefully tested, etc., the cost of maintenance should not be serious. An estimator usually values this at from £4 to £6 per £1,000 of work.

60. Conditions of Contract.—There is often an item in the preliminaries referring the builder to the conditions of contract for any items not mentioned in the quantities. These conditions should be carefully read, and, if necessary, a sum included for any items that have not already been allowed for.

61. Provisions.—Provisional amounts and prime-cost sums should be clearly defined in the preliminaries, also whether prime cost means the list price, or the net price after all trade discounts have been deducted. The clause relating to this should be carefully read, as on its proper understanding depends the treatment of all such amounts in the bills. In cases where the contract issued by the Royal Institute of British Architects is to be used, the estimator must add for profit, packing, and carriage, and, if necessary, also for fixing.

EXCAVATOR AND CONCRETOR

62. Excavation.—The main factors to be considered in estimating the price of excavation are the cost of labour, the nature of the soil to be excavated, and, where the surplus excavated material has to be removed off the site, the distance away of the

nearest shoot, and what the cost will be per load or cubic yard. The nature of the soil, if not already known, may be found out by visiting the site. If sand is likely to be found during the excavation or on the site, and there is no stipulation that sand shall not be dug for, the builder will be able to obtain the sand required for concrete and mortar, etc., free of cost, and, at the same time, save the carting away of surplus material to the extent of the capacity of the sand pits. Finding sand on the site would be a great saving to the builder, but generally, when there is the likelihood of much sand being found, the builder must give a credit for the amount used in the work. The cost of cartage can generally be obtained from a local carman, who will contract not only for the carting of surplus excavated material, but for all the carting necessary for the work, if the builder so desires.

63. It must be remembered that all material increases in bulk after excavation, and therefore a cubic yard of excavation will result in more than a cubic yard of excavated material. Therefore, in arranging any price with carmen, it must be clearly understood that the price is to be per load containing 1 cubic yard before excavating. It is estimated that sand and gravel increase in bulk from one-tenth to one-twelfth, earth and clay increase about one-fourth, and chalk about one-third. A load is generally understood to be equal to 1 cubic yard of earth, rubbish, etc., before excavation. An ordinary one-horse cart will hold about $1\frac{1}{2}$ cubic yards, a navvy's large wheelbarrow about $\frac{1}{10}$ cubic yard, and a basket about $\frac{1}{21}$ cubic yard. The least width in which a man can comfortably work is 2 feet 6 inches, and even then digging will take longer and therefore cost more than over a large area.

64. In Table X is given the time taken in digging, filling, basketing, returning, etc., which, although only approximate, can be taken as a fair average on which to base prices. The staging for each additional throw beyond the first height of 5 or 6 feet is generally considered to be equal to about 1d. per yard cube on the price of excavation. The use and waste of timber in strutting, etc., for the sides of the excavation, including

fixing and removing, is valued from 1s. to 1s. 3d. per foot cube. Planking and strutting for the sides of excavation is generally priced from 2d. to 3d. per foot superficial. The excavation of trenches will take from 20 to 30 per cent. longer than the time given in the table.

TABLE X

MEMORANDA FOR EXCAVATOR

Labour	Cubic Yards in 1 Hour
Shovelling building rubbish, sand, or loose soil that requires no digging	$2\frac{1}{5}$
Digging in vegetable soil or made ground and throwing out	$1\frac{1}{4}$ to $1\frac{1}{2}$
Digging in loamy clay and throwing out	$1\frac{1}{2}$ to $1\frac{3}{4}$
Digging in common ground and throwing out	$\frac{4}{5}$ to 1
Digging in stiff clay or gravel and throwing out	$\frac{1}{2}$ to $\frac{3}{4}$
Digging in chalk and throwing out	$\frac{1}{2}$
Digging in hard ground where picking is required	$\frac{1}{4}$ to $\frac{1}{2}$
Each additional throw beyond the first 5 or 6 feet in height, according to material	$1\frac{3}{4}$ to 3
Filling into barrows or baskets	$3\frac{1}{2}$
Filling into carts	2 to $2\frac{1}{4}$
Wheeling a distance of about 20 yards, which equals 1 run, and depositing	3
Basketing a distance of about 20 yards and depositing	$1\frac{1}{2}$
Returning or filling in excavated material	2
Ramming the material as it is returned or filled in	2
Levelling common soil from heaps without throwing	6

EXAMPLE 1.—What is the price of a yard cube of excavation over surface not exceeding 6 feet deep when the material is to be wheeled 1 run and deposited? The soil may be assumed as made ground and the workmen as receiving 7d. per hour.

SOLUTION.—According to Table X, from $1\frac{1}{4}$ to $1\frac{1}{2}$ cu. yd. of made ground can be dug and thrown out in 1 hr.; taking $1\frac{1}{4}$ cu. yd., so as to

be on the safe side, 7d. will pay for $1\frac{1}{4}$ cu. yd.; therefore 1 cu. yd. will cost 7d. $\div 1\frac{1}{4} = 6$d. As $3\frac{1}{2}$ cu. yd. can be filled into barrows in 1 hr., to fill 1 cu. yd. will cost 7d. $\div 3\frac{1}{2} = 2$d. As 3 cu. yd. can be wheeled 1 run and deposited in 1 hr., to wheel and deposit 1 cu. yd. will cost 7d. $\div 3 = 2\frac{1}{3}$d., or $2\frac{1}{4}$d. Therefore the cost of the excavating, wheeling, and depositing will be 6d. + 2d. + $2\frac{1}{4}$d. = $10\frac{1}{4}$d., to which must be added profit. Assuming the profit as 15 per cent., this will be $1\frac{1}{2}$d., making the total cost $11\frac{3}{4}$d. The price in the bill will therefore probably be 1s. per yd. cu. Ans.

Example 2.—Find the price of a yard cube of excavation to form trenches not exceeding 6 feet deep, the material being returned, filled in, and rammed. Assume that the soil is common ground and that the workmen are paid 7d. per hour.

Solution.—According to Table X, from $\frac{4}{5}$ to 1 cu. yd. of common ground can be dug and thrown out in 1 hr. Taking the smaller quantity, or $\frac{4}{5}$ cu. yd., the excavation of 1 cu. yd. will cost 7d. $\div \frac{4}{5} = 8\frac{3}{4}$d., or 9d. To this must be added an average between 20 and 30 per cent., or 25 per cent., for being in trenches, which will be $2\frac{1}{4}$d. As the material can be returned or filled in at the rate of 2 yd. in 1 hr., it will cost 7d. $\div \frac{1}{2} = 3\frac{1}{2}$d. per yd. Ramming the material will cost the same; therefore the work will cost 9d. + $2\frac{1}{4}$d. + ($3\frac{1}{2}$d. × 2) = 1s. $6\frac{1}{4}$d. Adding 15 per cent. for profit will give 1s. 9d. per yd. cu. as the total cost. Ans.

Example 3.—What is the price of a yard cube of excavation to form trenches, not exceeding 6 feet deep, where the material is carted away? Assume that the soil is common ground, that the workmen are paid 7d. per hour, and that arrangements have been made for carting away, including the finding of a shoot, at 3s. 6d. per load.

Solution.—The digging will cost the same as in example 2, or 9d. + $2\frac{1}{4}$d. = $11\frac{1}{4}$d. According to Table X, the carts can be filled at the rate of about 2 yd. per hr., so that $3\frac{1}{2}$d. will pay for this. To this must be added 3s. 6d. per yd. for carting. Adding to this 15 per cent. for profit, the cost will be

$$11\tfrac{1}{4}\text{d.} + 3\tfrac{1}{2}\text{d.} + 3\text{s. } 6\text{d.} + (4\text{s. } 8\tfrac{3}{4}\text{d.} \times \cdot 15) = 5\text{s. } 5\tfrac{1}{4}\text{d. Ans.}$$

The estimator may decide that less than 15 per cent. profit will be sufficient on the amount to be paid for carting.

65. Broken Brick or Stone.—Broken brick or stone, or what is sometimes described as *hard dry material*, is the brick and dry rubbish that accumulates on the site in the ordinary course of building, or while pulling down old work. It must be broken into suitable pieces to spread and level under floors or to form aggregate for concrete. When there is not sufficient on the site, the inferior new bricks must be used for this purpose, or

the material can very often be obtained from an old building that is being pulled down in the vicinity. The labour only of breaking old bricks into pieces about 2 inches cube is from 2 to $2\frac{1}{2}$ hours per yard cube. The labour of breaking stone will vary with the different kinds, but it will average from about 5 hours per yard cube for sandstone to 10 hours for hard limestone. Spreading, levelling, and ramming can be done at the rate of about 4 yards superficial per hour.

66. Portland Cement.—Portland cement is purchased by the ton, but the number of bags, in which the cement is contained,

TABLE XI

MEMORANDA FOR PORTLAND CEMENT

1 striked imperial bushel	=	1·284, or about $1\frac{1}{4}$ feet cube
	=	·0475, or about $\frac{1}{21}$ yard cube = 8 gallons
1 heaped imperial bushel	=	1·625 feet cube
1 striked imperial bushel	=	112 pounds
2 striked imperial bushels	=	224 pounds = 1 bag or sack
20 striked imperial bushels	=	2,240 pounds = 10 bags or sacks
10 bags or sacks	=	1 ton

London Custom

1 trade bushel	=	100 pounds
2 trade bushels	=	200 pounds = 1 bag or sack
22 trade bushels	=	2,200 pounds = 11 bags or sacks
11 bags or sacks	=	1 ton or 1 yard cube.

that is required to make a ton varies throughout Great Britain. The most usual weights are given in Table XI ; it will be noticed that the imperial bushel is the standard measurement, but in London the trade bushel is used. The weight of the bags should not be included. The merchant, as a rule, simply loans the bags, and if the builder returns them within 1 month, carriage paid, the amount charged as deposit is returned, less 1d. When arrangements are made with a merchant for the cement to be delivered on the job, the price quoted is usually exclusive of the charge for sacks.

To find the cost of cement on the site, when a price is quoted per ton by a manufacturer at the works or manufactory, which usually includes the loading into barges, sufficient must be added to cover the cost of the freight to the nearest docks, for unloading and wharf charges, for cartage from the wharf to the site, for use of bags, and for the cost of returning the empty bags.

67. Lime.—Greystone lime is sold by the yard cube, which contains 16 trade bushels ; it is usually delivered in sacks that contain 2 bushels each. Stone lime can be obtained either in lumps or ready ground. Ground blue lias lime is bought by the ton, which equals $1\frac{1}{2}$ cubic yards, and is delivered in 10 bags. The number of bushels to the ton varies according to the freshness of the lime, but a fair average is 30, so that 3 bushels equal 1 bag, and 30 bushels equal 10 bags, or 1 ton, or $1\frac{1}{2}$ cubic yards.

68. Sand.—The sand used in concrete and mortar is pit, river, or sea, though the last is very often prohibited. Sand is purchased by the yard cube. It takes a labourer about 1 hour to screen 1 cubic yard. Washed sand loses one-quarter of its bulk in washing, so that about $1\frac{1}{4}$ yards must be allowed for each yard required of washed sand ; it takes a labourer about 3 hours to wash 1 cubic yard, measured after washing.

69. Ballast.—Under the term **ballast** is included burnt ballast and Thames ballast. The former is burnt clay or brick earth, and the latter a natural mixture of gravel or shingle with sand. The proportion of sand in Thames ballast is usually about 1 part of sand to 2 parts of gravel or shingle, so that when used as an aggregate for concrete, there is generally no need to add further sand. Ballast is sold by the yard cube. From 1 to 2 hundredweights of fuel will be required to burn 1 cubic yard of clay for ballast, while 1 *chaldron*, or 36 heaped imperial bushels, of breeze will burn from 10 to 12 cubic yards of clay.

70. Coke Breeze.—The coke breeze so often used as an aggregate for concrete, because of its lightness, can generally be obtained from any gasworks, but it has to be well washed before using. Coke breeze must usually pass through a $\frac{1}{2}$-inch mesh ; it is sold in London by the chaldron.

71. Water.—The amount of water required for mixing concrete depends entirely on the materials used ; generally speaking, $\frac{3}{4}$ to 1 gallon is sufficient for every foot cube and from 20 to 25 gallons per yard cube. The mixing of neat cement requires about 40 gallons per yard cube. Based on a charge made by some water companies, 1d. per yard cube is sometimes added to the price of concrete for the value of the water ; but generally water for the whole of the works is dealt with under a separate item and a lump sum included. In Table XII is given the weight of water.

TABLE XII

WEIGHT OF WATER

1	gallon	= 10 pounds, or ·16 foot cube
$6\frac{1}{4}$	gallons	= $62\frac{1}{2}$ pounds, or 1 foot cube
224	gallons	= 1 ton, or 36 feet cube

72. Concrete.—The main factors in the value of concrete are the component parts and the proportion in which they are to be mixed. The component parts can be divided into the matrix, which consists of either lime or cement mixed with sand, and the aggregate, which is ballast, broken brick or stone, or coke breeze. Sometimes, in describing concrete, the sand is considered as part of the aggregate, so that before starting to build up the price of concrete this point should be clearly settled. For instance, concrete is sometimes spoken of as " 6 to 1 " ; this may mean 6 parts of Thames ballast to 1 part of cement or lime, and as the former contains a certain proportion of sand, the sand becomes part of the aggregate ; it may also mean 6 parts of gravel, 2 parts of sand, and 1 part of cement or lime, in which case the sand is part of the matrix.

73. Since the lime and sand or cement and sand forming the matrix do little more than fill in the voids in the aggregate and do not increase the volume to any great extent, 4 parts of ballast, 2 parts of sand, and 1 part of cement or lime only represent just over 4 parts by volume, and not $4 + 2 + 1 = 7$. In one experiment, a dry mixture of 1 part of Portland cement, 2 parts of sand, and 4 parts of gravel, after being wet, turned over, thoroughly mixed, and well rammed in place, had shrunk about

20 per cent., or one-fifth. If lime instead of cement had been used, the shrinkage would have been more. Therefore a fairly safe rule is to make an allowance of from 20 to 30 per cent., or an average of 25 per cent., on the total amount of material, ignoring only the lime or cement, that is mixed dry to find the amount of concrete that will be actually deposited in place and rammed.

The time taken in mixing up concrete varies according to the size of the gang who are shovelling, mixing, sprinkling water, etc. However, progress is considered satisfactory if concrete is mixed, wheeled, deposited, and rammed at the rate of 1 yard cube for 3 hours of a labourer.

EXAMPLE 1.—Find the price of a yard cube of concrete composed of 6 parts of Thames ballast to 1 part of greystone lime, when the ballast can be delivered on the site for 5s. per yard cube, the lime at 11s. 6d. per yard, including the use of sacks, and the labourers are paid 7d. per hour. The value of the water for mixing is not to be taken into consideration.

SOLUTION.—As 6 yd. of ballast at 5s. a yd. will cost 30s. and 1 yd. of lime will cost 11s. 6d., the material for 6 yd. of aggregate will cost 30s. + 11s. 6d. = 41s. 6d. But since the aggregate will shrink 25 per cent., the actual concrete laid will be 6 yd. − (6 × ·25) = $4\frac{1}{2}$ yd. Therefore 1 yd. of concrete will cost 41s. 6d. ÷ $4\frac{1}{2}$ = 9s. 3d., nearly, for material. Allowing a labourer, at 7d. an hr., 3 hr., the mixing and depositing will cost 7d. × 3 = 1s. 9d., and as 15 per cent. profit on 9s. 3d. + 1s. 9d. is 1s. 8d., nearly, the yard cube will cost 12s. 8d. Ans. Probably the price of such an item would be given as 12s. 6d.

EXAMPLE 2.—What is the price of a yard cube of concrete composed of 5 parts of gravel, 2 parts of sand, and 1 part of Portland cement? The gravel is delivered on the site at 5s. 6d. per yard cube, the sand at 6s. per yard, and the cement at 28s. per ton, including the use of sacks; the ton can be taken as equal to a yard cube. The labourers are paid 7d. per hour. The value of the water is not to be included.

SOLUTION.—As 5 yd. of gravel at 5s. 6d. a yd. will cost 27s. 6d., 2 yd. of sand will cost 12s., and 1 yd. of cement will cost 28s., the material for 7 yd. of aggregate will cost 27s. 6d. + 12s. + 28s. = 67s. 6d. But since the aggregate will shrink 25 per cent., the amount of concrete laid will be 7 yd. − (7 × ·25) = $5\frac{1}{4}$ yd. Therefore 1 yd. of concrete will cost 67s. 6d. ÷ $5\frac{1}{4}$ = 12s. 10d., nearly, for material. Allowing a labourer, at 7d. an hr., 3 hr., the mixing and depositing will cost 7d. × 3 = 1s. 9d., and as 15 per cent. profit on 12s. 10d. + 1s. 9d. is 2s. 2d., the yard cube will cost

12s. 10d. + 1s. 9d. + 2s. 2d. = 16s. 9d. Ans.

74. Surface Concrete.—The cost of a yard superficial of concrete over a surface is found by taking a proportion of the cost of a yard cube. For instance, 1 yard superficial 6 inches thick equals $\frac{1}{6}$ yard cube plus the extra labour of spreading and levelling. This extra labour is generally considered equal to about $\frac{1}{3}$ or $\frac{1}{4}$ hour of a labourer for every yard superficial.

BRICKLAYER

75. Bricks.—Bricks are always sold by the thousand, but as the prices fluctuate considerably, quotations should be obtained from the manufacturers as may be necessary. Cartage or carriage from the manufacturers to the site and the consequent handling in loading and unloading must always be taken into consideration in estimating the cost of bricks delivered on the site. Stocks and ordinary facing bricks weigh 55 to 60 hundredweights, glazed bricks about 65 hundredweights, and Staffordshire blue bricks 90 hundredweights per thousand. A cartload is 500 bricks and a railway truckload 3,000 bricks After 24 hours' immersion in water, ordinary bricks absorb one-fifth or one-sixth of their weight, and Staffordshire blue and similar bricks one-fifteenth to one-twentieth.

76. Mortar.—Directly after the price of bricks has been obtained, the value per yard cube of the different kinds of mortar to be used should be found, so that for items of brickwork, facing, etc., these prices will be ready at hand. It is generally better to work out the cost of the mortar at the prime cost and add the profit at the same time as the profit is added on the material with which the mortar is used.

An important factor to be taken into consideration is that all mortar shrinks considerably when mixed ; the shrinkage varies according to the proportions of the materials, the amount of water used, and the state of the lime or cement. Cement mixed neat shrinks about 10 per cent., sand 20 per cent., cement and sand in equal proportions 19 per cent. To find the value of mortar, it is sufficiently accurate to assume that lime and sand mixed for mortar shrink 25 per cent., or one-fourth, in bulk, and cement and sand 17 per cent., or one-sixth.

77. The ingredients may be mixed either by hand or with a mortar mill; they are better mixed by the latter method, and the cost is very much cheaper provided a sufficient quantity is required each day to make it worth while having a mill on the site. Mixing by hand must generally be resorted to for work of an ordinary nature. By this method, it may be estimated that 1 yard cube of lime mortar will require 8 hours of a labourer, while cement mortar will require an average of 12 hours. A load of mortar equals 1 yard cube, 27 feet cube, 21 bushels, or 40 hods. A bricklayer's hod is 16 inches by 9 inches by 9 inches and has a capacity of $\frac{2}{3}$ foot cube, or nearly $\frac{1}{2}$ bushel of mortar.

EXAMPLE 1.—Find the prime cost of a yard cube of mortar composed of 2 parts of sand to 1 part of greystone lime, assuming that the sand is delivered on the site at 6s. a yard cube, the lime at 11s. 6d. a yard, including the use of sacks, and the labourers are paid 7d. an hour. The water for mixing is not to be included.

SOLUTION.—As 2 yd. of sand at 6s. a yd. will cost 12s. and 1 yd. of lime 11s. 6d., 3 yd. of the material before mixing will cost 12s. + 11s. 6d. = 23s. 6d. But since lime mortar loses 25 per cent., or one-quarter, by shrinkage, the amount of mortar will be 3 yd. − (3 × ·25) = $2\frac{1}{4}$ yd. Therefore 1 yd. of mortar will cost 23s. 6d. ÷ $2\frac{1}{4}$ = 10s. 5d. Allowing a labourer, at 7d. an hr., 8 hr., the mixing will cost 7d. × 8 = 4s. 8d. Therefore the total prime cost of 1 yd. cube of lime mortar will be

10s. 5d. + 4s. 8d. = 15s. 1d. Ans.

EXAMPLE 2.—Give the prime cost of 1 yard cube of mortar composed of 3 parts of sand to 1 part of Portland cement. The sand is delivered on the site at 6s. a yard cube and the Portland cement at 28s. a ton, or cubic yard, including the use of sacks. The labourers are paid 7d. an hour.

SOLUTION.—As 3 yd. of sand at 6s. a yd. will cost 18s. and 1 yd. of Portland cement 28s., 4 yd. of the material before mixing will cost 18s. + 28s. = 46s. But since cement mortar loses 17 per cent. by shrinkage, the amount of mortar will be 4 yd. − (4 × ·17) = $3\frac{1}{3}$ yd. Therefore 1 yd. of mortar will cost 46s. ÷ $3\frac{1}{3}$ = 13s. 10d., nearly. Allowing a labourer 12 hr., at 7d. an hr., the mixing will cost 12 × 7d. = 7s. Therefore the prime cost of 1 yd. cube of cement mortar will be

13s. 10d. + 7s. = 20s. 10d. Ans.

78. Brickwork.—To find the value of brickwork, not only must the cost of bricks and mortar be considered, but also the amount of each that will be required, together with the value of scaffolding and the labour expended in laying the bricks. It

will be found expedient to value brickwork always in the same way, either at so much a rod or yard, or by some other standard measurement. In London, the **standard rod** is used; its values are given in Table XIII.

TABLE XIII

STANDARD-ROD EQUIVALENTS

1 standard rod = $30\frac{1}{4}$ yards super = 272 feet super of $1\frac{1}{2}$ bricks
= $45\frac{1}{4}$ yards super = 408 feet super of 1 brick
= $11\frac{1}{3}$ yards cube = 306 feet cube

The first point to determine is the number of bricks required per standard rod. This number varies considerably, but it is safe to assume that from 4,300 to 4,400, or an average of 4,350, per rod will be sufficient. This allows for a reasonable amount of waste bricks in cutting, etc. The amount of mortar required per rod is rather difficult to determine, but a fair average is 2 yards cube per rod with $\frac{1}{4}$-inch joints, or 3 yards cube for $\frac{3}{8}$-inch joints. The allowance for scaffolding varies from 4s. to 6s. per rod; the latter amount is based on the assumption that a scaffolder in 1 day will erect and remove sufficient for 1 rod. For estimating purposes, 5s. per rod can be taken as a fair average price. A bricklayer with his attendant labourer will lay from 45 to 85 bricks an hour; of course, more bricks can be laid in thick walls than in thin ones, as the face work is less in proportion. A very fair average for brickwork in lime mortar is 70 bricks an hour, or from 60 to 63 hours per rod.

79. Brickwork in cement mortar will take longer than that in lime mortar, so that 9 or 10 hours more should be allowed for each rod. Brickwork in backing to masonry and brickwork circular on plan necessitate more waste in cutting, and consequently more labour in building. For backing to masonry, it is generally considered that about 400 or 500 more bricks will be required, and from $4\frac{1}{2}$ to 6 hours longer for bricklayer and labourer per rod; for work circular on plan, from 200 to 250 more bricks and from 12 to 15 hours longer for bricklayer and labourer.

EXAMPLE.—Find the cost of a rod of brickwork built with stock bricks in lime mortar. The stocks are delivered on the site for 32s. per 1,000,

the prime cost of the mortar can be taken as 15s. 1d. per yard cube, and the labourers are paid 7d. per hour and the bricklayers $10\frac{1}{2}$d. per hour.

SOLUTION.—Allowing 4,350 bricks to the rod, at 32s. per 1,000, the bricks will cost £6 19s. 3d.; at 15s. 1d. a yd., 2 yd. of lime mortar will cost £1 10s. 2d.; therefore the material will cost £6 19s. 3d. + £1 10s. 2d. = £8 9s. 5d. As it will require 63 hr. to lay them, this work will cost $63 \times (7\text{d.} + 10\frac{1}{2}\text{d.})$ = £4 11s. 11d. Allowing 5s. for the use of the scaffolding and 15 per cent. for profit, the total cost will be

£8 9s. 5d. + £4 11s. 11d. + 5s. + (£8 9s. 5d. + £4 11s. 11d. + 5s. × ·15)
= £15 6s. 3d. Ans.

In a case like this, the price might be entered as £15 6s., which equals 1s. $1\frac{1}{2}$d. a ft. superficial of reduced brickwork, for 272 × 1s. $1\frac{1}{2}$d. = £15 6s.

80. Brick Facings.—To find the extra value of facing and pointing over and above the cost of the ordinary brickwork, it is necessary to consider the extra cost of the bricks and the value of the labour and material in pointing. The extra cost of the bricks will depend on whether the facing is to be carried out with bricks that have been only selected and picked from the general building bricks, or whether with special facing bricks. In the former case it will generally take a labourer about 1 hour to select from the general stock 290 to 300 bricks suitable for facing; in the latter case, a quotation must be obtained for the special facing bricks in the ordinary way. Facings require 7 bricks per foot superficial. It is estimated that a bricklayer will strike the joints of about 100 bricks an hour, and will require about 1 foot cube of mortar for every 400 bricks.

EXAMPLE 1.—Find the extra cost, per foot superficial, of facing with stocks selected and picked from the general building bricks finished with a neatly struck joint in lime mortar; the prime cost of the mortar can be taken as 7d. per foot cube, the labourers are paid 7d. an hour, and the bricklayers $10\frac{1}{2}$d. an hour.

SOLUTION.—For ease in working items like this, it is more convenient to take a greater quantity than 1 ft. superficial, for instance, 100 ft., and then find the cost of 1 ft. at the end of the calculation. Since 7 bricks are required for 1 ft. superficial, or 700 bricks for 100 ft., and as the labourer will pick 300 bricks in 1 hr., it will require $700 \div 300 = 2\frac{1}{3}$ hr. to pick out the bricks. At 7d. an hr. this work will cost 7d. × $2\frac{1}{3}$ = 1s. $4\frac{1}{3}$d. As it will require 1 ft. cube of mortar for pointing 400 bricks, 700 bricks will require $700 \div 400 = 1\frac{3}{4}$ ft. cube; this will cost, at 7d. per ft. cube, 7d. × $1\frac{3}{4}$ = 1s. $0\frac{1}{4}$d. The bricklayer will strike the joints of 100 bricks

in 1 hr.; to strike the joints of 700 will therefore require 700 ÷ 100 = 7 hr., and this, at $10\frac{1}{2}$d. an hr., will cost $10\frac{1}{2}$d. × 7 = 6s. $1\frac{1}{2}$d. The prime cost of 100 ft. superficial is therefore 1s. $4\frac{1}{3}$d. + 1s. $0\frac{1}{4}$d. + 6s. $1\frac{1}{2}$d. = 8s. 6d., nearly. Allowing 15 per cent. profit, the total cost will be 9s. 9d. The cost of 1 ft. is therefore 9s. 9d. ÷ 100 = $1\frac{1}{4}$d., very nearly. Ans.

EXAMPLE 2.—Find the extra cost, per foot superficial, of facing with approved red bricks finished with a neatly struck joint in cement mortar. The red bricks are delivered on the site at 80s. per 1,000, while the ordinary building bricks cost 32s. per 1,000. The prime cost of the mortar is 9d. per foot cube, the labourers are paid 7d. an hour, and the bricklayers $10\frac{1}{2}$d. an hour.

SOLUTION.—As the red bricks will cost 80s. per 1,000 and the ordinary bricks 32s., the extra cost for the bricks will be 80s. − 32s. = 48s. per 1,000. Since 7 bricks are required to each foot, or 700 bricks for 100 ft., the extra cost of the facing bricks will be 700 ÷ 1,000 × 48s. = 33s. 7d. The mortar costs 9d. per ft. cube, which is sufficient to point 400 bricks; therefore the mortar will cost 9d. × 700 ÷ 400 = 1s. $3\frac{3}{4}$d. As a bricklayer strikes the joints of 100 bricks in 1 hr., it will require 7 hr. to strike the joints of 700 bricks; at $10\frac{1}{2}$d. an hr. this will cost $10\frac{1}{2}$d. × 7 = 6s. $1\frac{1}{2}$d. The prime cost of 100 ft. is therefore 33s. 7d. + 1s. $3\frac{3}{4}$d. + 6s. $1\frac{1}{2}$d. = 41s. $0\frac{1}{4}$d. Adding to this 15 per cent. for profit gives for the total cost of 100 ft.

$$41\text{s. } 0\tfrac{1}{4}\text{d.} + (41\text{s. } 0\tfrac{1}{4}\text{d.} \times \cdot 15) = 47\text{s. } 2\tfrac{1}{4}\text{d.}$$

This amount divided by 100 gives nearly $5\frac{3}{4}$d. per ft. superficial. Ans.

81. Arches in Brick Facings.—Arches in brick facings require about ten bricks to the superficial foot against seven for facing. A bricklayer requires from $\frac{1}{3}$ hour for rough arches to $\frac{3}{4}$ hour for gauged arches to each foot superficial.

DRAINLAYER

82. Pipes.—When pricing drain pipes, the cost of the material and labour of laying and jointing must be added to the cost of the pipes. Glazed-stoneware drain pipes are made in 2-foot and 3-foot lengths; the trade discount may be as much as from 20 to 45 per cent. off the makers' list. Tested pipes usually cost about 25 per cent. more than the ordinary ones. It has been estimated that 1 bushel of neat cement is required for every 36 joints in 4-inch pipes and for every 24 joints in 6-inch pipes, while 1 bushel of cement and sand will be sufficient for

150 feet run of 4-inch pipes and 100 feet run of 6-inch pipes. It is also assumed, when estimating, that a bricklayer with a labourer attending will lay and joint 10 feet run of 4-inch pipes or 7 feet run of 6-inch pipes in 1 hour.

EXAMPLE.—What is the price of a foot length of 6-inch glazed-stoneware drain pipe, laid and jointed in cement, if the pipe is delivered on the site at 5d. per foot run? Portland cement is 1s. 6d. a bushel; the bricklayer is paid $10\frac{1}{2}$d. an hour and the labourer 7d. an hour.

SOLUTION.—To the price of the pipe, or 5d., must be added the cost of $\frac{1}{2\frac{1}{4}}$ bush. of cement at 1s. 6d. a bush., or $\frac{3}{4}$d., and $\frac{1}{7}$ hr. for both bricklayer and labourer for the laying and jointing, or $\frac{1}{7} \times (10\frac{1}{2}\text{d.} + 7\text{d.}) = 2\frac{1}{2}$d. Adding to this 15 per cent. for profit makes the cost of 1 ft. of pipe

$$5\text{d.} + \tfrac{3}{4}\text{d.} + 2\tfrac{1}{2}\text{d.} + (5\text{d.} + \tfrac{3}{4}\text{d.} + 2\tfrac{1}{2}\text{d.} \times \cdot 15) = 9\tfrac{1}{2}\text{d.} \quad \text{Ans.}$$

83. Trenches and Concrete Beds.—The excavation of trenches and the concrete beds for drain pipes are valued as for other work of this nature, except that a percentage must be added for the increased cost of labour on account of the work being in small quantities and all having to be set out to proper falls. A rough-and-ready way of finding the cost of digging trenches for drain pipes is to allow 1d. per foot run for each foot in depth, but it is not very reliable, as in some cases the cost is very much in excess of it.

84. Extras on Drain Pipes.—The items of bends, taper pipes, and junctions are usually given in the quantities as *extra for*; that is, the length of these pieces is included in the total length of the straight pipes, so that the value is only the difference in cost of the bend or junction, etc., over that of a similar length of straight pipe, plus, probably, an extra joint and also the additional profit. On examining a trade price list, it will generally be found that bends are charged 3 times, taper pipes and single junctions are charged 4 times, and double junctions 6 times the price of 1 foot of straight pipe of the same diameter. Bends, taper pipes, and single junctions displace about 2 feet, and double junctions 3 feet, of straight pipe.

85. Connections to Sewers.—The value of the connections of new drains to the main sewers will vary according to the amount of work that will be done by the local authorities. Information

on this point and also the amount of the fees that must be paid can always be obtained on application at the borough surveyor's office. To this amount, the estimator must add sufficient for the work that has to be done by the builder and for profit.

86. Gullies and Traps.—The main factor in the cost of all gullies and traps is the actual cost of the article from the maker. To this price must be added the cost of digging, concrete bed, cement for jointing, time for setting and jointing, and profit. It is generally estimated that a bricklayer will set and joint a gully complete in about 1 hour.

87. Manholes.—The work of building manholes and inspection chambers should be valued at the same rate as similar work, except that a percentage should be added for the increased cost of labour on account of the work being in small quantities.

WALLER

88. All rubble for walling is sold by weight ; 1 ton of rubble equals 22 to 26 feet cube, or an average, for estimating purposes, of 24 feet cube. A yard cube of random rubble walling, allowing for waste, requires $1\frac{1}{4}$ yards cube, or $1\frac{1}{3}$ tons, of rubble and 9 feet cube, or $\frac{1}{3}$ yard, of mortar ; a waller and a labourer will take on an average about 3 hours to lay 1 yard cube. Coursed rubble walling will require more rough stone than will random work, owing to there being more waste ; consequently the labour will be greater, but less mortar will be required. A fair proportion for 1 yard cube of coursed rubble walling is $1\frac{1}{3}$ yards cube, or $1\frac{1}{2}$ tons, of rubble and $6\frac{1}{2}$ feet, or $\frac{1}{4}$ yard, cube of mortar ; 5 hours' time should be allowed the waller and labourer. Scaffolding is usually considered to be worth about 6d. per yard cube. Raking out joints and pointing rubble walling will vary from 9d. to 1s. 3d. per yard superficial.

MASON AND TERRA-COTTA WORKER

89. Stone.—The main factors to be taken into consideration in estimating the price of stonework are : (*a*) The price of stone at the quarry, (*b*) the cost of carriage, (*c*) the waste in the

conversion of the rough stone into the required sizes and shapes, (*d*) the cost of labour when working the stone, (*e*) the cost of carriage from the builder's yard to the site, (*f*) hoisting and setting, (*g*) profit. A truckload of stone is considered to be about 4 tons and upwards. One ton of Bath, Doulting, or Portland stone will equal about 16 feet cube, while $13\frac{1}{2}$ feet cube of granite will weigh 1 ton. There will be a saving in weight for carriage when the stone is worked at the quarry, but usually 10 per cent. more is charged for the carriage of worked stone than for rough.

The waste in the conversion of stone from the random blocks into the finished stones must always be taken into consideration, especially when the amount of stone given in the bills of quantities has been obtained by taking the actual measurements of the stone when fixed in the work. This waste is estimated at from 5 to 15 per cent.; many estimators always allow 5 per cent., while others never allow less than 10 per cent. Most builders will know by careful observation how much stone, on an average, is cut to waste by their masons.

90. Labour.—The cost of labour in working stone to the finish and profile required is the most important factor in the pricing of stone. Seasoned stone is harder to work than freshly quarried stone. Stone worked by machinery is from 50 to 60 per cent. cheaper than that worked by hand, but machinery is usually found only at the quarries or exceptionally large yards. Granite is usually worked at the quarry, as it is easier to work before the quarry sap has dried out, and also because of the great difficulty experienced in working this stone by hand. Stone worked in position will cost from 40 to 50 per cent. more than at the yard or quarry, and circular work from 50 to 75 per cent. more than straight.

91. As Portland stone is the one most used, the labours on it have become, in London, the basis for the prices of all labour; the cost of labours on other stones is considered as a percentage below or above this basis. It is estimated that a mason will take on an average $\frac{3}{10}$ hour for each superficial foot of half-sawing on Portland stone, $\frac{1}{2}$ hour for beds and joints, $1\frac{1}{6}$ hours

for plain-face work, $1\frac{1}{2}$ to $2\frac{1}{4}$ hours for sunk work, and $3\frac{1}{4}$ to $3\frac{1}{2}$ hours for moulded work. Work finished with a rubbed face will take 20 to 30 per cent. longer than the foregoing. The labours on Bath stone are about 45 per cent. less than on Portland stone, while on York stone they are 25 per cent. more, and on granite 50 to 60 per cent. more. Bath stone and all labour is often considered as 25 per cent. less than Portland stone. One foot cube of stone requires about $\frac{1}{7}$ foot cube of mortar, and a mason with his attendant labourer will take on an average $\frac{1}{4}$ to $\frac{1}{2}$ hour per foot cube for hoisting and setting.

92. Terra-Cotta. — The price of terra-cotta can usually be obtained from the manufacturer, including all models and delivery on the job. To this price must be added the cost of filling the blocks with concrete, hoisting and setting, and profit. The amount of concrete required for filling will usually be from two-thirds to three-quarters of the total cubic quantity of terra-cotta. A bricklayer and labourer will take about $\frac{2}{5}$ hour per foot cube for hoisting and setting. When brickwork has not been deducted for what is displaced by the terra-cotta, the value of such brickwork will reduce the price per foot cube of the terra-cotta. Failing any definite information, it will be sufficiently accurate to assume that $\frac{3}{4}$ foot cube of brickwork is displaced for each foot cube of terra-cotta.

SLATER

93. Slates. — Slates are bought by the trade 1,000, which equals 1,200. Although known by names which represent different sizes, such as *countess*, 20 inches by 10 inches, and *duchess*, 24 inches by 12 inches, the sizes vary slightly according to the different quarries. To the price of the slates at the port, the estimator has to add for loading on to rail or vessel, carriage to nearest railway terminus or port, unloading, cartage to the site, nails, preparing slates, fixing, and profit. About 30 countess or 20 duchess slates of first quality weigh 1 hundredweight ; the second-quality slates will weigh more, owing to their being thicker. A square of 100 feet superficial of roofing will

require 170, or one-seventh of a trade 1,000, countess slates laid to a 3-inch lap ; or 115, which equals $\frac{2}{7}$ of a trade 1,000, duchess slates laid to the same lap. For estimating purposes it is usual to allow, in addition to the foregoing, about 5 per cent. for waste.

94. Nails and Fixing.—Two nails must be allowed to each slate, and 5 per cent. must be added to the number for waste; there are three sizes mostly used, namely, $1\frac{1}{4}$, $1\frac{1}{2}$, and 2 inches. The weight of nails per 1,000 is often stated in the description of the slating ; if it is not, it can be assumed that composition nails will weigh from 6 pounds per 1,000 for $1\frac{1}{4}$-inch nails to 10 pounds for 2-inch, while copper nails will weigh from $5\frac{1}{2}$ pounds for $1\frac{1}{4}$-inch to 11 pounds for 2-inch.

Preparing slates and fixing, which must include the holing of the slates, will vary according to the size of the slates. The larger the slates the quicker can they be prepared and laid. For estimating purposes, a fair average is to allow 3 hours of slater and labourer per square of 100 feet superficial for preparing and fixing. Slating fixed vertically will take about 50 per cent. longer, so that $4\frac{1}{2}$ hours of slater and labourer must be allowed per square for preparing and fixing. The extra waste and labour for circular slating will represent an increase in cost of from 25 to 35 per cent. Slating sublet to slate merchants is usually cheaper on account of their buying in very large quantities.

TILER

95. Tiles.—Tiles are sold by the 1,000, not 1,200, as are slates , the 1,000 equals one load. Plain tiles are about $10\frac{1}{2}$ inches by $6\frac{1}{2}$ inches and pan tiles $13\frac{1}{2}$ inches by $9\frac{1}{2}$ inches. To the price of the tiles at the local station where manufactured, the estimator has to add for the railway rate to the nearest station, unloading, cartage to the site, pegs, fixing, and profit. About 50 plain tiles weigh 1 hundredweight, or 1 ton contains 1,000. For a square of 100 feet superficial of roofing there will be required 555 plain tiles laid to a 4-inch gauge, 635 laid to a $3\frac{1}{2}$-inch gauge, and 740 laid to a 3-inch gauge ; in addition, about $2\frac{1}{2}$ per cent. should be allowed for waste.

96. Pegs and Fixing.—Oak pegs or galvanized-iron nails are used for fixing the tiles. If each tile is to be fixed, two pegs must be allowed to each tile, plus 5 per cent. for waste. These pegs are bought by the hundredweight and weigh about 25 pounds per 1,000. The average length of time taken by a tiler and labourer for fixing the tiles for a square of 100 feet superficial is about 7 hours. If the tiles are bedded, an additional $1\frac{1}{2}$ hours for each must be allowed and also, on an average, $2\frac{1}{2}$ feet cube of mortar per square.

97. Battening or Lathing.—The battening or lathing for the roof tiling is very often included with the description of the tiling, and so has to be added to the price of the tiling. Tiling laths are sold, in lengths of from 3 to 5 feet, in bundles consisting of 500 feet run. A square of plain tiling laid to a 4-inch gauge requires 300 feet run of laths; laid to a $3\frac{1}{2}$-inch gauge it requires 340 feet, and when laid to a 3-inch gauge, 400 feet. An allowance of 5 per cent. should be made for waste in addition to the foregoing. From 1 to $1\frac{1}{4}$ pounds of lathing nails will be required to each square of lathing. A carpenter will take about 3 hours per square to fix the laths.

CARPENTER AND JOINER

98. Introduction.—The items generally found in the bill for the carpenter and joiner are of great variety. Both trades are difficult to price, and yet they are of the utmost importance, as very often they represent 30 per cent. of the total value of the building. It is quite impossible to give any data that will be useful throughout the British Isles, as local and other circumstances with regard to timber and workmen vary considerably.

Only builders having a large business and timber merchants buy direct from the shippers, so that dock charges, carriage, etc., need not be considered. Also, there are very few builders who buy in large bulk from timber merchants and convert the timber into the scantlings required. The amount of waste and the cost of sawing and converting into the different scantlings required on a job, therefore, will not be considered here, but only a brief outline of the distinctions made in buying and selling timber.

99. Balk Timber and Deals. — Balk timber is sold by the load, which contains 50 cubic feet, or 218 linear feet of $11'' \times 3''$ material, 267 linear feet of $9'' \times 3''$ material, and 343 linear feet of $7'' \times 3''$ material. Deals are usually sold by the St. Petersburg standard, which contains 165 cubic feet, or 720 linear feet of $11'' \times 3''$ material, which equals 660 feet superficial 3 inches thick, or 1,440 linear feet of $11'' \times 1\frac{1}{2}''$ material, which equals 1,320 feet superficial $1\frac{1}{2}$ inches thick. Flooring, rough boarding, and match boarding are usually sold by the square, which contains 100 feet superficial. Mouldings, beads, and small scantlings are bought by the 100 linear feet.

Balk timber is usually the trunk of a tree sawn or hewn square with an axe; it is used for large scantlings such as are often required in carpenter's work. **Deals** is a general term for timber not more than 4 inches thick, and is applied to those scantlings required for joiner's work, and very often for carpenter's work also. Under this general term *planks*, *deals*, and *battens* are bought. Scantlings that can be obtained from deals or planks with very little, if any, sawing are cheaper than those obtained from balk timber. Not only is the sawing, and consequent waste, less, but timber bought by the standard is, in proportion, cheaper than that bought by the load.

100. Carpenter's Work.—Very few builders convert the timber from the balk or deals, but obtain quotations from the nearest timber merchant or sawmills for all the different scantlings and lengths that may be required. This price is generally at so much per foot cube, and usually includes the delivery on to the site. For all carpenter's work, the price obtained will be the basis for all the different items, the estimator adding for the fixing, including nails, etc., and profit. Care must be taken that there is no misunderstanding with the timber merchants or sawmills as to whether the quotations are for finished sizes or not. The preamble to the carpenter's bill should clearly state whether all the scantlings are to be the full sizes or whether they are to be less the waste in sawing from large timbers.

101. Joiner's Work.—Only those builders with large joiners' shops make their own windows, doors, and other framed work.

They usually enter into an agreement with the nearest joinery works to provide the material and deliver on to the site the various articles ready for fixing ; this price includes, very often, for the priming coat of paint and sometimes for the glazing. In coming to this agreement, there must be no misunderstanding as to whether the quotations are for finished sizes or not. Most sizes given in the joiner's bill are the sizes of the timber from which the articles are to be prepared, and, of course, after having been planed and worked, will not hold up to the sizes given ; the preamble to the joiner's bill should clearly state what is intended.

The quotations so obtained will form the basis on which the estimator will price the many items and to which he will add for labour, nails, and screws in fixing and for profit. The builder must supply all the necessary drawings, details, and exact sizes, the latter being usually taken by the foreman on the works and sent to the builder's office, whence they are forwarded to the joinery works, together with all the necessary details and sketches.

102. Nails and Screws.—Nails are sold by the hundredweight, according to the length, the smaller the nails the greater being the price. Screws are sold by the gross. The cost of nails and screws for each particular item, at per foot cube, superficial, or run, in the carpenter's and joiner's bill, is very small, but on a job of any size the cost for the amount required is considerable and must not be overlooked.

103. Timber at Per Foot Cube.—To the price of timber at per foot cube delivered must be added not only profit, but also an allowance for waste and the time taken in fixing. A general allowance of 5 per cent. for waste will usually be sufficient, and for timber in plates, etc., about $\frac{1}{2}$ hour per foot cube will be required by the carpenter for fixing. Timber that is framed will take about $\frac{1}{2}$ hour longer, or 1 hour in all, per foot cube for framing and fixing.

104. Boarding.—Ordinary rough boarding for roofs and flats can be fixed by a carpenter at the rate of about 3 hours per square ; each square will require about 3 pounds of nails. If the boarding has to be traversed for lead or zinc, another 1 to 2 hours per square must be allowed for. Furrings for falls, so

often included with the boarding for flats, are worth from 3s. to 5s. per square in addition.

105. Floors.—To the price per square of flooring delivered on the site, in addition to profit, there must be allowed about 10 per cent. for waste, 6 pounds of nails, and the labour of laying and cleaning off; the time taken by the carpenter for laying and cleaning off will vary with the description and thickness of the flooring. For estimating purposes, it can be reckoned that a carpenter will take from 4 hours per square for straight-joint flooring 1 inch thick up to 7 hours for tongued-and-grooved flooring 2 inches thick.

106. Skirtings.—Skirtings are usually sold by 100 feet run. When estimating, the following allowances must be made: For waste, from 10 to 15 per cent.; nails, 2 to $2\frac{1}{2}$ pounds per 100 feet; and for fixing and cleaning up, about $\frac{1}{6}$ hour per foot run. Mitred angles, housings, fitted ends, etc., are worth, on an average, about the value of 1 foot run of skirting.

107. Windows.—Under the heading of windows in a bill of quantities will be found casements and cased frames and sashes. Sashes of ordinary size will take a carpenter about $1\frac{1}{2}$ hours each for hanging; cased frames of ordinary size will require about 2 hours for fixing.

108. Doors and Framings.—The price of all doors and gates must include for hanging and for fixing only the hinges; the cost of the hinges will be included in the ironmonger's bill. The hanging of a door containing from 18 to 21 feet superficial will take a joiner about $1\frac{1}{2}$ hours. Doors with the top panels prepared for glass are usually considered to be worth 1d. per foot superficial more than similar doors with solid panels. Doors with segmental heads can be priced at 25 per cent. more than similar doors with straight heads, and those with semicircular heads at 50 per cent. more than those with straight. Irregular-shaped framing in spandrels, etc., is worth from 20 to 25 per cent. more than similar square framings. Framings of all descriptions which are circular on plan will cost from one and a half to twice the price of similar straight framing.

109. Door and Window Frames, Etc.—Allowance must be made, in addition to the price for all frames delivered on the site, not only for profit, but for fixing. A door frame representing about 17 feet run will take a carpenter from 1 to $1\frac{1}{2}$ hours to fix; solid window frames will be in proportion. Transoms and mullions are usually considered to be worth about 10 per cent. more than the same scantlings in ordinary frames.

110. Mouldings.—Mouldings that must be made to detail will cost about 10 per cent. more than those of stock sections; it is generally stated in the preamble to the joiner's bill which are to be used. An allowance of 10 per cent. should be made for waste on all mouldings, so that for every 100 feet brought on to the job only about 90 feet can be reckoned as actually fixed. A joiner will take from 10 to 12 hours to fix 100 feet of architrave moulding, and will use from $2\frac{1}{2}$ to 3 pounds of nails.

111. Staircases.—To the price obtained from the joinery mills for staircase work must be added the cost of fixing and the profit. Fixing will take a carpenter, on an average, $\frac{1}{2}$ hour per foot superficial. When treads and risers are mitred to cut strings, the extra cost will be about 6d. per end or 1d. per foot superficial. Very often the width of the strings is not given in the bill, in which case they may be assumed as being 12 inches wide.

Hand rails are generally worked to detail at the joinery mills. An allowance of $7\frac{1}{2}$ to 10 per cent. must be made for waste, while $\frac{1}{4}$ hour per foot run of the carpenter's time will be required for fixing. If the hand rail is in long lengths and hand-rail joint screws are required, allowance must be made for one every 7 to 10 feet. A carpenter will take from 1 to $1\frac{1}{4}$ hours for each joint, and the cost of the hand-rail screw will be about 3d. Ramped hand rails are usually priced at twice the cost of straight, circular at $2\frac{1}{2}$ times, and wreathed at 3 times.

112. Hardwoods.—Joiner's work carried out in hardwoods is very often, so as to avoid many calculations, priced at a percentage above the cost of similar work in deal. A fair average for this work is as follows: Pitch pine, from 10 to 15 per cent.

above the price of similar work in deal; teak, wainscot oak, and Honduras mahogany, $2\frac{1}{2}$ to 3 times the price of deal; and Spanish mahogany about 4 times the cost of deal.

IRONMONGERY

113. Purchasing ironmongery locally is the most expensive way of buying, and is only resorted to when very few articles are required. When prime-cost sums are included for each article no difficulty will be found in pricing, but when list or catalogue prices are stated care must be taken, as these prices are subject to a trade discount of anything from 5 to 33 per cent. The many qualities of ironmongery make a considerable difference in the cost, so that if no prime-cost or list prices are stated, inquiry should be made as to the quality, whether the very best, middling, or quite cheap work is intended. An estimator will soon know, either from the style of building or from previous work carried out for the architect, about the quality for which he must include. Having decided on the general quality, quotations should be obtained from one of the manufacturers.

114. Screws and Fixing.—Unless specially stated or arranged for, the prime-cost, or catalogue prices, and the quotations for ironmongery do not include the requisite screws for fixing. The cost of these screws can usually be covered by adding from 1d. to 2d. for each article. To the cost of the ironmongery delivered on the site not only must allowance be made for screws and profit, but also for the fixing. Much time is often wasted in fixing ironmongery through the articles being given to a few joiners without clear instructions as to where they are to be fixed. Consequently, on the architect's next visit, numberless alterations must be made, with the result that the estimate for fixing is not by any means sufficient. Fixing ironmongery is usually one of the last occupations for the joiners, so that the rate of progress will depend very much on the supervision of the foreman. A careful foreman will sort the ironmongery, obtain clear instructions from the architect as to the positions

of the several articles, and then explain to the joiner at each door, window, etc., what is intended, and will see from time to time that no mistakes are being made.

115. A fair allowance of time for a joiner to fix to deal is as follows: From $\frac{1}{4}$ hour for a pair of $2\frac{1}{2}$-inch butts up to $\frac{1}{3}$ hour for a pair of 4-inch; cross-garnets, about $\frac{1}{2}$ hour per pair; bolts, an average of $\frac{1}{2}$ hour each; cupboard locks, $\frac{1}{2}$ hour; rim and rim dead locks and furniture, 1 hour; mortise locks and furniture, 2 hours per lock; sash fasteners from $\frac{1}{4}$ to $\frac{1}{3}$ hour each. Fixing to hardwoods will take from 20 to 25 per cent. longer.

FOUNDER AND SMITH

116. The basis of most of the items to be found in the bill of founder and smith is the weight of the several articles; the great difference to be noticed in the cost of articles is the amount of labour compared with the weight. As the prices of iron and steel fluctuate greatly, it is always advisable to obtain quotations for all the work included in the bill from the nearest founder or smith. These quotations should always include for the delivery on to the site, and to them should be added for profit and fixing.

117. Cast Iron.—The fixing of cast-iron columns, stanchions, etc., can be taken as worth from 1s. to 2s. per hundredweight. The cost of rain-water pipes and eaves gutters, etc., may be obtained from the manufacturers; to this price should be added from 2d. to 3d. per foot run for fixing.

118. Wrought Iron.—It is impossible to give any general data as to the cost of fixing articles made of wrought iron, as they are very numerous and vary for each building to such an extent that few of the articles can be termed standard. As a rule, the cost of fixing must be judged from the description. Many of the wrought-iron articles need no actual fixing by the smith, but are prepared by him at the smithy and fixed by one of the allied trades; for instance, chimney bars are fixed by the bricklayer and roof straps by the carpenter.

Wrought iron is sold in plates, sheets, square or round bars, and rods. Plates vary from $\frac{1}{8}$ to 1 inch in thickness and can be obtained up to 15 feet long and 4 feet wide. Sheets are under $\frac{1}{8}$ inch in thickness and can be obtained up to 8 feet long and 3 feet wide. Square and flat bars vary from 1 inch by $\frac{1}{4}$ inch to 6 inches by 2 inches and can be obtained in lengths up to 20 feet. Round bars can be obtained from $\frac{5}{8}$ inch to 3 inches in diameter; under $\frac{5}{8}$ inch diameter they are termed rods, and can be obtained in lengths up to 30 feet. Galvanized corrugated sheet iron is usually bought by the foot superficial, according to the gauge; the price includes the requisite bolts, washers, nails, screws, etc. From 2d. to 3d. per foot for fixing should be added to the quotations obtained.

119. Steel.—The preamble to the bill should definitely state whether English or foreign steel is to be used; it is specially important to know this for large amounts of steelwork, so that the quotations can be obtained accordingly. Belgian steel is from 10 to 15 per cent. cheaper than English. An extra charge is usually made for all joists and girders over 36 feet long and also for those that have to be cut to within an inch either way of the length required. An allowance must be made for hoisting and fixing all steelwork; the former can be treated on a basis of about 1d. per hundredweight per 10 feet in height of hoisting, and the latter as 2 hours for both the smith and the mate per hundredweight when it is necessary for the smith to be on the job to fix. Steel joists without any connection to other joists or steelwork will usually be put into position by labourers under the direction of the foreman. Holes in steelwork are punched, unless otherwise directed; drilled holes are charged extra.

120. Galvanizing.—The cost of galvanizing ironwork varies with the size of the articles to be treated, but a fair price is from 7s. 6d. for large pieces up to 10s. per hundredweight for articles weighing under 28 pounds. The coating of pipes with Dr. Angus Smith's solution will cost about $\frac{1}{2}$d. per foot run.

121. Wrought-Iron Tubing.—The iron pipes used for water, gas, and hot-water work are usually wrought-iron lap-welded

tubing. This tubing is made in three qualities: ordinary, steam, and water. The current prices for tubing and all the necessary accessories may be obtained from the manufacturers or merchants, to which must be added for profit and fixing. Fixing, including red lead, hooks, etc., is worth from 2d. to 3d. per foot run.

PLASTERER

122. The items found in a plasterer's bill must be based on the current prices of the several kinds of materials used; to these must be added the cost of all labour and the profit. Quotations should be obtained, in the ordinary way, from merchants for all the materials required; these quotations should include for the delivery on to the site.

123. Water and Scaffolding. — In pricing plasterer's work, an allowance must be made for water and also for the fixing and removing of scaffolding. As a rule, both these items are dealt with separately, a lump sum being included for the whole of the works. If not dealt with under lump-sum amounts, usually $\frac{1}{4}$d. per yard will cover the cost.

124. Lime and Cement.—The cost of stone and blue lias lime and of Portland cement for the plasterer must be obtained in the same manner as for the concretor. Plaster of Paris and Parian and Keene's cements are much used in plasterer's work. The quantities in which they are sold are given in Table XIV.

TABLE XIV

PLASTER OF PARIS, AND PARIAN AND KEENE'S CEMENT

1 bag	= 14 pounds	1 sack	= 2 hundredweights
1 bushel	= 75 pounds	10 sacks	= 1 ton [= 3 bushels

125. Hair.—A bushel of dry hair equals about 14 pounds, and 1 foot cube weighs about 11 pounds. Usually, about 1 pound of hair is required to every 3 feet cube of coarse stuff.

126. Nails.—The nails for lathing are either wrought, cut, or cast; for good work, they should be galvanized. The number of nails in 1 pound varies with their length, and the length used

depends on the thickness of the lath. About 950 nails are in 1 pound of $\frac{3}{4}$-inch nails, which are used for single laths, while only 750 nails are in 1 pound of 1-inch nails, which are used for double laths.

127. Lathing.—Laths are cut from 2 to 5 feet long and are sold in bundles containing 360 to 500 feet run; a plasterer generally assumes that 100 laths are in a bundle. Laths are 1 inch wide and vary in thickness. Single laths are from $\frac{1}{8}$ to $\frac{3}{16}$ inch thick, lath and a half average about $\frac{1}{4}$ inch thick, and double laths are from $\frac{3}{8}$ to $\frac{1}{2}$ inch thick. It is generally assumed that 1 yard superficial of lathing will require about 24 laths 3 feet long and $\frac{1}{8}$ pound of nails, and $\frac{2}{9}$ hour for both the plasterer and labourer to fix.

128. Plastering on Brickwork.—The first coat of plastering on brickwork is known as *rendering*, the second as *floating*, and the third as *setting*. One yard superficial of rendering will require about ·01 yard cube of lime, ·02 yard cube of sand, ·16 pound of hair, and ·2 hour for both plasterer and labourer. One yard superficial of rendering and setting with fine stuff will require about ·02 yard cube of lime, ·02 yard cube of sand, ·25 pound of hair, and ·3 hour for both plasterer and labourer. One yard superficial of rendering, floating, and setting with fine stuff will require about ·023 yard cube of lime, ·023 yard cube of sand, ·3 pound of hair, and ·5 hour for plasterer and labourer.

129. Plastering on Lathing.—The first coat of plastering on lathing is known as *plaster*, the second coat as *floating*, and the third as *setting*. In addition to the data given for lathing, 1 yard superficial will require about the following: Lath and plaster, ·01 yard cube of lime, ·02 yard cube of sand, ·16 pound of hair, and ·15 hour for both plasterer and labourer; lath, plaster, and set, ·02 yard cube of lime, ·02 yard cube of sand, ·28 pound of hair, and ·25 hour for both plasterer and labourer; lath, plaster, float, and set, ·025 yard cube of lime, ·025 yard cube of sand, ·32 pound of hair, and ·4 hour for both plasterer and labourer.

130. Moulded Work.—Moulded work in cornices, etc., is usually priced at about 1d. per foot run per inch of girth, so that

1 foot superficial of cornice will cost 1s. ; but much will depend on the pattern of the cornice and the length to be executed, as the price must include for the moulds or templates. Stopped ends to mouldings are usually considered to be worth about ½ foot run of the moulding and the mitres are worth 1 foot run.

PLUMBER

131. The basis of the leading items of leadwork to be found in a bill of plumber's work is the weight. Milled lead is rolled in sheets from 3½ to 9 feet wide and 20 to 35 feet long, and weighs from 1 to 12 pounds per foot superficial. Lead pipes up to 2 inches in diameter are sold in coils containing 40 to 60 linear feet ; lead pipes over 2 inches in diameter are sold in lengths of about 10 feet. Lead pipes are usually given in the bill by the foot run, but the weight is given per yard run, so that when the price per hundredweight for pipes is obtained it is easy to find the fraction of a hundredweight that 1 foot of any given size of pipe will weigh. The price of lead fluctuates considerably, and quotations must always be obtained for any quantity that is required, unless the builder has sufficient on hand to carry out the work, when the cost is easily found. To the price of the lead must be added an allowance for profit, and the cost of labour, solder, etc., required for laying.

132. **Milled Lead.**—With milled lead there is a certain amount of waste from cuttings and small pieces which cannot be used. These waste pieces are easily sold at from 2s. to 2s. 6d. per hundredweight less than the current price of new lead ; but when the pieces are weighed, it is the custom to deduct 4 pounds per hundredweight, or, in other words, 116 pounds of cuttings will be sold as 1 hundredweight. To allow for this waste, it is usually sufficient to add 2½ per cent. to the cost of the lead. Milled lead laid in gutters, flats, flashings, etc., will require about 1½ pounds of solder to each hundredweight of lead. The solder used by the plumbers is worth from 6d. to 9d. per pound. A plumber and his mate will require from 3½ to 4 hours per hundredweight for laying.

133. Lead Pipes.—In pricing lead pipes, it is advisable to allow for waste the same as for milled lead. The amount of time taken for fixing will depend on the workmen ; an estimator will soon learn the rate of progress of the plumbers employed by the builder. It is fairly safe to allow from $\frac{1}{6}$ hour for plumber and mate per foot run of $\frac{3}{4}$-inch pipe up to $\frac{1}{2}$ hour for 4-inch pipe. A wiped soldered joint of a $\frac{1}{2}$-inch pipe to a brass union will require about $\frac{3}{4}$ pound of solder and will take a plumber and mate about $\frac{1}{4}$ hour; for a 4-inch pipe, this joint will require $4\frac{1}{2}$ pounds of solder and will take a plumber and mate $\frac{1}{2}$ hour.

134. Brass Work and Fittings.—The price of brass work used by the plumber and the cost of fittings, when a prime-cost or list price is not given, can only be obtained by getting quotations or from the price lists issued by a manufacturer. To these prices must be added profit and the cost of fixing.

GLAZIER

135. English sheet glass is sold in crates containing 200 to 400 feet superficial ; foreign sheet glass, in cases of 200 to 300 feet superficial. British polished plate glass can be obtained in very large squares containing 100 feet superficial or more in area. A general allowance is $\frac{1}{4}$ hour per foot superficial for cutting to sizes and glazing.

Glazing is usually sublet to a glass merchant, which is undoubtedly the cheapest way. Special quotations can always be obtained for large or small quantities, so that, generally, the estimator sends the glazier's portion of a bill of quantities to a glass merchant, and, on receiving a price, simply adds for the profit required.

PAINTER

136. A painter uses a large number of materials which fluctuate in price ; among these are glue and red lead for knotting ; putty, pumice stone, and glasspaper for stopping ; and red lead, dry white lead, boiled oil, raw linseed oil, turpentine, driers, etc., for ordinary painting. The proportion of materials

used will vary according to the surface to be painted and also with the nature of the paint. Each coat requires less paint for the same area than the previous coat. It is estimated that 1 pound of ready-mixed paint will only cover about 4 yards superficial for the first coat on wood, while for the fourth coat it will cover about 7 yards superficial. Also, 1 pint of varnish covers about 8 yards superficial for the first coat and 13 yards for the second. A painter will take about ·1 hour for knotting and stopping 1 yard superficial and ·14 hour for applying each coat of paint, except the first or priming coat, which will take ·16 hour. Painting on iron or steel takes longer, ·25 hour per yard superficial being required for the first coat and ·22 hour for each succeeding coat.

137. Very few estimators go into the price of painting with any great care, and certainly in very few cases is there time to properly analyze the cost of all the items found in the painter's bill. As the work contained in this bill is not usually very expensive, compared with the other trades, the prices may often be assumed. Many estimators take 3d. per yard superficial for each coat, counting the priming as one coat but ignoring the knotting and stopping. An estimate for the painting of an old building must be carefully gone into, as the cost of ladders, cradles, carting, washing down implements, etc., will add greatly to the cost.

PAPERHANGER

138. A piece of English paper is 36 feet long by 21 inches wide, which equals 63 feet superficial, or 7 yards. An allowance of 1 yard per piece has already been made to the quantity given in the bill of quantities, for, in reducing the number of feet to pieces, the divisor is 54. A piece of French paper varies in size, but is generally 27 feet long by 18 inches wide, which equals $40\frac{1}{2}$ feet, or $4\frac{1}{2}$ yards, superficial. A piece of Japanese paper is about 36 feet long by 12 inches wide. Price lists are generally subject to a discount of 33 per cent. If the prices are given in the bill in this way, it will be safe to assume 33 per cent. as the discount, but more often than not the prices given are prime cost.

One piece of paper will usually take a paperhanger about 1 hour to cut, paste, and hang. Preparing the walls, including pumicing and stopping, will require about $\frac{3}{4}$ hour per piece. From $\frac{1}{5}$ to $\frac{1}{4}$ gallon of paste, costing about 3d., will be required per piece. Very few estimators make a true analysis of this trade, and when list prices are stated they usually add from 9d. to 1s. per piece to cover the cost of preparing the walls, hanging, and for profit.

LONDON BUILDING LAW

(PART 1)

LAW AND ADMINISTRATION

ACTS, BY-LAWS, AND REGULATIONS

ORDER OF IMPORTANCE

1. Acts Affecting Building Work.—The requirements affecting the erection of buildings in London are contained in numerous Acts of Parliament, by-laws, and regulations. The Acts may be placed in three divisions: (*a*) those dealing directly with the construction of buildings; (*b*) those dealing with drainage and sanitation; (*c*) those of general application, but which contain provisions affecting building work. The Acts coming within the first division are the London Building Act, 1894, and its amending Acts of 1898 and 1905. Those in the second division are the Metropolis Management Act, 1855, and its various amending Acts, the principal of which are those of 1862 and 1878, and an Act, practically restricted to sanitary requirements, which is known as the Public Health (London) Act, 1891. In the third division are the various General Powers Acts of the London County Council; the most important of these, considered from the building standpoint, are those of 1902, 1908, and 1909. The third division also includes the Acts that have still less direct influence on building work, and apply outside as well as inside the Metropolis, the principal of which are the Factory

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and Workshop Acts, 1901 and 1907, and the Housing and Town Planning Act, 1909.

2. **By-Laws.**—A large proportion of the detailed requirements with regard to drainage and sanitation are contained in **by-laws.** The by-laws made under the Metropolis Management Act, 1855, deal with the question of the construction and ventilation of drains, soil, and waste pipes. By-laws made under the Public Health (London) Act, 1891, deal with the provision of water-closets, earth-closets, privies, cesspools, and ash-pits. Those made under the Metropolis Management Amendment Act, 1899, govern the submission of plans for drainage and sanitary work. The remaining by-laws have reference to the construction of buildings. Those made under the Metropolis Management and Building Acts Amendment Act, 1878, deal with the excavation of unsanitary material from the site of a building, the materials used in the construction of walls, and such questions of detailed construction as the formation of foundations, the provision of a damp-proof course in every wall, and of a layer of concrete over the site of every building. There are also by-laws made under the London County Council (General Powers) Act, 1890, which extend the provisions of the by-laws mentioned with regard to the excavation of unsanitary material from the soil before the commencement of building operations, and regulate the materials to be used in the execution of plastering. Although the provisions of the General Powers Act of 1890 which have reference to building work have been repealed, the by-laws made under this Act still remain in force.

3. **Regulations.**—Several sets of **regulations** have been made by the London County Council. The most important of these are the regulations made under the Metropolis Management and Building Acts Amendment Act, 1878, with regard to the construction of theatres, music halls, concert halls, and similar places of public resort. The other regulations deal with the submission of plans to the County Council, and the provision of means of escape in case of fire.

4. **Principal Requirements.** — The requirements which are most likely to be encountered by persons erecting buildings in

London are those contained in the London Building Act, 1894, and its amending Act of 1905, and in the by-laws relating to drainage, sanitation, and the construction of buildings. The 1898 amendment of the Building Act of 1894 is of comparatively small importance, and few of the provisions of the Metropolis Management Acts and of the Public Health (London) Act will need to be considered in the erection of ordinary buildings. The provisions of the General Powers Act, 1908, however, have considerable influence on the construction of large buildings used for trade or manufacture, and the provisions of the General Powers Act, 1909, which admit of the erection of buildings of steel-frame construction, must sometimes be considered.

5. Administrative Authorities.—A knowledge of the several administrative authorities and the scope of their jurisdiction is almost as important as an acquaintance with the Acts themselves. Leaving the City of London to be dealt with later, there are three classes of administrative authorities in the Metropolis. There are, first, the London County Council; second, the various metropolitan borough councils, including the City of Westminster ; and third, the officials who, by reason of their office, have control over certain matters. These statutory officials consist of the superintending architect, who holds the position of chief architect to the County Council, and the district surveyors, of whom there are about fifty in the Metropolis, each having charge of a separate district. Both the superintending architect and the district surveyors are appointed by the County Council, but, once appointed, these officials are able to exercise certain discretionary powers without any reference to the County Council. District surveyors derive their income from fees payable in respect of the erection of new buildings and the carrying out of alterations of a structural nature to existing buildings.

6. The County Council are the principal administrative body in London and exercise a general control over the administration of the building law. Throughout the Building Acts this body are referred to as the Council. Drainage and sanitary matters are directly administered by the borough councils, but

there is the right of appeal to the County Council against the action of a borough council in respect to any such matter. The district surveyors also exercise immediate control over the numerous questions of construction and arrangement which are dealt with in the Building Acts. But such Acts, in many cases, provide that a modification or relaxation of the requirements may be obtained by special consent, applications for which must in almost every case be made to the County Council.

7. Tribunal of Appeal.—The decisions of the County Council, the superintending architect, and the district surveyors may, in certain instances specified in the London Building Act, 1894, the amending Act of 1905, and the London County Council (General Powers) Act, 1909, be made the subject of an appeal to a *Tribunal of Appeal* specially constituted to deal with matters of this kind. The **Tribunal of Appeal** ordinarily consists of three members, one appointed by the Home Secretary, one by the Council of the Royal Institute of British Architects, and one by the Council of the Surveyors' Institution. When the Tribunal adjudicate on appeals under the London County Council (General Powers) Act, 1909, which deals with the construction of steel-frame buildings, a fourth member is added, who is appointed by the Council of the Institution of Civil Engineers.

8. Building Law in the City of London.—The whole of the Acts, by-laws, and regulations that have been referred to apply throughout the full extent of the Metropolis, with the important exception of the City of London. The Metropolis Management Acts have no practical application in the City of London, their place being taken by the City of London Sewers Acts, 1848, 1851, and 1897. The ordinary metropolitan drainage, sanitary, and building by-laws do not apply in the City of London. The place of the drainage by-laws is taken by regulations, and there are sanitary by-laws, made under the City of London (Various Powers) Act, 1900, which are very similar to the ordinary metropolitan by-laws made under the Public Health (London) Act, 1891. The Building Acts and the constructional provisions of the London County Council (General Powers) Acts,

1908 and 1909, with the exception of a few provisions, apply in the City. The principal of these is Part III of the London Building Act, 1894, which deals with lines of building frontage. Such requirements as apply with regard to this question in the City are contained in the City of London Sewers Acts. The Factory and Workshop Acts apply throughout the whole of London, including the City. The special City requirements are administered by the City Corporation, who also administer those provisions of the London Building Act, 1894, which have reference to dangerous and neglected structures and sky signs.

9. Study of the Building Law.—A proper knowledge of the building law can be obtained only by a study of the Acts, by-laws, and regulations themselves; but progress is greatly facilitated if the chief points are summarized and explained. The Metropolis Management Acts and the Public Health (London) Act, 1891, need not receive much attention, but the Building Acts, together with all by-laws and regulations, should be carefully studied. The County Council issue a publication, termed the *London Building Acts*, which contains the principal requirements of the building law, including the by-laws and regulations.

LONDON BUILDING ACT, 1894

SCOPE OF ACT

CHIEF PROVISIONS

10. Main Building Act. — The London Building Act, 1894, which came into operation on January 1, 1895, contains a large portion of the general building law, and, as some of its requirements are not very easy to understand, the Act should be read very carefully. The Act is divided into sixteen parts, the most important of which are Parts II, III, V, VI, VII, and VIII. The first five of these six parts contain requirements, enforced by the public authorities, which are framed with a view to obtaining the proper carrying out of building work. Part VIII deals

exclusively with questions arising between private parties in connection with the construction or alteration of party walls. Other parts which are of importance are Parts IX and XI, which deal respectively with dangerous and neglected structures and the erection of dwelling houses on low-lying land. It is generally considered that the requirements of Part V with regard to the provision of open spaces about buildings are by far the most difficult to understand.

11. Most Important Sections.—The chief sections in the Act of 1894 are Section 5, which contains a long list of definitions; Section 9, which gives a list of cases in which it is possible for the County Council to refuse to sanction the formation of a proposed new street; Section 13, which regulates the distance of new buildings and structures from the centre of narrow streets; Section 22, which deals with the general line of buildings and does not apply in the City of London; Section 41, which requires the provision of open space at the rear of buildings; and Sections 47 and 49, which regulate the heights of buildings. To these must be added the First Schedule, which specifies the thickness of walls, and almost all the sections in Parts VI and VII of the Act; that is, Sections 53 to 86, inclusive. All the requirements with regard to construction which are contained within these two parts demand close attention, for the majority of them apply to practically every building. A person who is familiar with these sections, and who has read enough of the remainder of the Act to understand its general scope, will have attained a fair working knowledge of its provisions. It is, of course, unnecessary to attempt to attain a word-for-word knowledge of the Act. It will be sufficient if such acquaintance with the Act is obtained as to enable it to be known what requirements apply in any case, and in what section or portion of the Act the details of such requirements may be found.

DEFINITIONS

12. Definitions Affecting Streets and Ways.—All the general definitions which apply throughout the Act of 1894 are contained in Section 5. The first definitions deal with the meaning

of the terms street, way, roadway, centre of roadway, and prescribed distance. The definition of *street* is very comprehensive, and as it includes a court, alley, or passage, the term street has legally a much wider meaning than that accepted in general conversation. That part of the definition of *centre of the roadway*, which refers to streets or ways in which the centre of the roadway has been defined by the Council or superintending architect, has very limited application; the centre of the roadway has been thus defined only in a very few streets. The definition of **prescribed distance** is as follows:

> The expression the prescribed distance means 20 feet from the centre of the roadway where such roadway is used for the purpose of carriage traffic, and 10 feet from the centre of the roadway where such roadway is used for the purposes of foot traffic only.
>
> NOTE.—In the text of the Act, periods are the only punctuation marks, but, in the quotations made, commas have been inserted in order that the requirements may be more easily understood.

13. Definitions of General Terms.—The definitions in Section 5, extending from *new building* to *cubical extent*, deal with a number of terms used in the design and erection of buildings. The most important of these definitions is that of *party wall*, for although party and external walls of similar length and height are required by the Act of 1894 to be of similar thicknesses, the provisions of the Act with regard to recesses and openings in party walls are much more stringent than those applying to recesses and openings in external walls. Further, the applicability of practically the whole of the provisions of Part VIII of the Act is dependent in any particular case on whether or not the wall in question is a party or an external wall. This is due to the fact that an external wall acts as an enclosure only, and is in single ownership, whereas a party wall forms a fire-check between buildings, and is in dual ownership. The definition of the term **party wall** is as follows:

> The expression party wall means
>
> (*a*) A wall forming part of a building and used, or constructed to be used, for separation of adjoining buildings belonging to different owners, or occupied, or constructed or adapted to be occupied, by different persons; or
>
> (*b*) A wall forming part of a building, and standing to a greater extent than the projection of the footings on lands of different owners.

This definition is to some extent affected by the provisions of Section 58 of the Act, which are as follows :

> In either of the following cases :
>
> (*a*) When a wall is, after the commencement of this Act, built as a party wall in any part, or
>
> (*b*) Where a wall, built before or after the commencement of this Act, becomes, after the commencement of this Act, a party wall in any part,
>
> the wall shall be deemed a party wall for such part of its length as is so used.

This section is thought to have been inserted to enable a person to erect a wall standing on the land of two owners without complying with the requirements of the Act in relation to party walls until there is a building on the other side of the wall, and the wall is thus used as a party wall.

14. Where one building is carried to a higher level than an adjoining building, from which it is separated at the level at which both buildings occur by a party wall, it is a question whether the dividing wall is a party wall throughout the whole of its height or whether it becomes an external wall in the portion where it acts as an enclosure to one building only. The importance of this question lies in the fact that, if the wall is a party wall, ordinary openings may not be formed in the wall ; whereas, if the upper portion of the wall is an external wall, it will be possible to form window openings in such portion for the purpose of lighting the taller building. The district surveyors and the officials of the County Council who are concerned with the administration of the building law almost invariably adopt the view that a wall which is a party wall in its lower portion is a party wall for the whole of its height. The law in this case appears, however, to be uncertain.

15. The definition of *cross-wall* must be read in conjunction with the requirements in the First Schedule of the Act of 1894. It is there provided that no wall subdividing a building is to be deemed a cross-wall unless it is carried up to the floor of the topmost story, and unless in each story the aggregate superficial extent of all recesses and openings, taken together, does not exceed one-half of the whole extent of the vertical elevation

of the wall. As the thickness of external, party, and cross-walls is regulated by length, measured between return walls, as well as height, and as a wall constructed as a cross-wall in accordance with the Act is recognized as a return wall, the necessity of being familiar with the requirements of the Act with regard to cross-walls is apparent.

16. The definitions of *area, square,* and *cubical extent* are of importance in connection with the few calculations which it is sometimes necessary to make when considering the application of the requirements of the Act of 1894. The *area* of a building must be calculated for the purpose of ascertaining the fee to be paid to the district surveyor; but calculations for this purpose are usually made by the quantity surveyor or contractor, and not by the architect. The number of *squares* in a building must sometimes be calculated in order to ascertain whether certain sections of the Act will apply. The provisions of the building law with regard to the limitation of the *cubical extent* of buildings used for trade or manufacture were originally contained in Sections 75 and 76 of the London Building Act, 1894. They have now been repealed, but similar and more extensive and elastic provisions are contained in Part III of the London County Council (General Powers) Act, 1908.

17. Definitions of Various Classes of Buildings.—The application of a large number of the requirements of the building law depends within which of several specified classes a building correctly falls, within the meaning of the London Building Act, 1894. The definitions of the various classes of buildings are thus of very great importance. These are given in Section 5, as follows:

The expression dwelling house means a building used, or constructed or adapted to be used, wholly or principally for human habitation.

The expression domestic building includes a dwelling house, and any other building not being a public building or of the warehouse class.

The expression public building means a building used, or constructed or adapted to be used, as a church, chapel, or other place of public worship; or as a school, college, or place of instruction, not being merely a dwelling house so used; or as a hospital, workhouse, public theatre, public hall, public concert room, public ball room, public lecture room, public library,

or public exhibition room; or as a public place of assembly; or used, or constructed or adapted to be used, for any other public purpose; also a building used, or constructed or adapted to be used, as an hotel, lodging house, home, refuge, or shelter, where such building extends to more than 250,000 cubic feet or has sleeping accommodation for more than 100 persons.

The expression building of the warehouse class means a warehouse, factory, manufactory, brewery, or distillery, and any other building exceeding in cubical extent 150,000 cubic feet, which is neither a public building nor a domestic building.

Unfortunately, however, these definitions are not in all respects very clear. It is often very difficult to decide whether a building is a domestic building or one of the warehouse class. It would appear that in a case of this kind the cubical extent of the building should be calculated. Then the two points, the construction and arrangement of the building and its cubical extent, whether above 150,000 cubic feet or not, must be taken into consideration.

18. **Definition of Owner.**—Throughout the Building Acts, the words *owner* and *occupier* are often found in cases where notice must be given to such persons, usually in instances of non-compliance with some requirements of the law. Also, in Part VIII of the London Building Act, 1894, the terms *building owner* and *adjoining owner* are frequently used. The definition of owner, as given in Section 5, is a very wide one, and in the case of leasehold property it is generally considered that there is more than one owner within the meaning of the Act. The general definition of the term owner which applies in the London Building Acts Amendment Act, 1905, is entirely different from that given in the Act of 1894.

19. **Miscellaneous Definitions.**—The remaining definitions contained in Section 5 of the Act of 1894 are of a general character. The definitions of *local authority* and *Commissioners of Sewers* require explanation in consequence of changes which have occurred since the passing of the Act. The vestries and the district and local boards were abolished by the London Government Act, 1899, and their duties transferred to the metropolitan borough councils which were created by the Act.

Thus, whenever the term local authority is used in the Building Acts, it means, in the City, the City Corporation; and in the rest of London, the local borough council. The Commissioners of Sewers of the City were abolished in 1897, and their duties transferred to the City Corporation.

The definition of *fire-resisting material* is included in Section 5, but this definition, together with the schedule of fire-resisting materials contained in the Act of 1894, has been repealed and replaced by the new definition and schedule of fire-resisting materials contained in the London Building Acts Amendment Act, 1905.

FORMATION OF STREETS

CONSENT REQUIRED

20. Submission of Plans.—Part II of the Act of 1894 deals principally with the formation of streets. Section 7 provides that before any person commences to form or lay out a street, whether for carriage traffic or for foot traffic only, an application, accompanied by plans, sections, and particulars in accordance with the Council's printed regulations, must be made by him to the Council. A copy of the regulations with regard to the submission of plans for various purposes can be obtained at the County Hall. The forming or laying out of a street must not be begun without the consent of the Council, but Section 9 provides that if within the period of 2 months from the date of the application the Council do not disapprove the application they shall be considered to have given their consent. This period, however, is extended for 28 days, by Section 174, in any case when the ordinary date of expiration occurs between August 8 and September 14. This extension of time applies to all cases under the Act in which there is a time limit within which the Council are required to issue a consent or disapproval.

21. Operations Constituting Formation of Street.—Section 8 specifies the operations which are to be considered as evidence of the commencement of the formation of a street. This section

specially must be held in mind, for the erection of a house in such a manner and in such a position that it will or may become one of a row of three or more houses may constitute the formation of a street. A person unfamiliar with this section might thus unwittingly contravene the requirements of the Act. There is, of course, the proviso at the end of the section which might be held to provide for such an unintentional infringement, but it is generally admitted that it is very difficult to determine, in many cases, whether or not the requirements of the Act have been contravened.

22. Cases Where Consent May Be Refused.—It is only in certain cases that the Council are able to refuse consent to an application for the formation of a street. These cases are specified in Section 9 of the Act. It should, however, be clearly understood that it is not essential, in making an application to the Council, to comply with all the requirements specified in this section. The Council have power to consent as they may think fit to any arrangement or form of construction, and often consent to plans which do not conform in all respects to the list of model requirements set forth. But the width of 40 feet for streets used for carriage traffic may be considered to be an invariable requirement.

23. Adaptation of Ways to Form Streets.—Sections 10 and 11 of the Act of 1894 deal with the question of the adaptation of ways for use as streets, and the adaptation for carriage traffic of streets or ways which have been used for foot traffic only. The requirements are very similar to those which apply with regard to the formation of new streets. In either case, the consent of the Council must be obtained prior to the commencement of the work, and, if the application is not disapproved within 2 months from the date of its receipt, the Council will be considered to have given their consent. The list, given in Section 11, of cases in which the Council may refuse to give their consent to a proposed adaptation of a way as a street, or of a street for carriage traffic which has been hitherto used for foot traffic only, is very similar to that given in Section 9 as regards the formation of new streets. The first of the seven

specified cases in which consent may be refused is worded differently, as there is the possible question of already existing buildings to be taken into account.

24. Increased Width of Street.—Section 12 of the Act of 1894 provides that where it is intended to form, lay out, or adapt for carriage traffic a street which is more than 2 miles from St. Paul's Cathedral, the Council may require, if the street will form an important thoroughfare, an increased width up to a maximum of 60 feet. Compensation for land taken in providing this increased width is payable in the cases specified in Section 15. This requirement as to increased width of street has hardly ever been put in force by the Council.

25. Right of Appeal.—Section 19 of the Act of 1894 provides that whenever any applicant for the Council's consent to the formation or laying out of a street, or the adaptation of a street or way for carriage or foot traffic, is dissatisfied with the refusal or conditional grant of such sanction or with any condition imposed by the Council, he may appeal to the Tribunal of Appeal. Regulations as to the procedure to be followed in making an appeal, and as to the fees to be paid, are issued by the Tribunal of Appeal and may be obtained at the offices of the Tribunal.

PRESCRIBED-DISTANCE REQUIREMENTS

BUILDINGS ABUTTING ON STREETS AND WAYS

26. Erection of Buildings in Narrow Streets. — Although Sections 13 to 17 of the Act of 1894 occur in Part II, they principally affect the erection of buildings. Subsection 1 of Section 13, which contains a general prohibition of the erection of buildings or structures within the prescribed distance from the centre of highways, is as follows :

> No person shall erect any new building or new structure, or any part thereof, or extend any building or structure, or any part thereof, in such manner that any external wall of any such building or structure, or, if there be a forecourt or other space between such external wall and the

roadway, any part of the external fence or boundary of such forecourt or other space, shall, without the consent in writing of the Council, be in any direction at a distance less than the prescribed distance from the centre of the roadway of any street or way, being a highway.

The requirement just mentioned is generally taken to imply that not only can no new building or structure be erected within the prescribed distance without the consent of the Council, but also that, when any new building is erected outside the prescribed distance, any existing forecourt fence or wall, which is situated at a less distance than the prescribed distance from the centre of the roadway, must be taken down unless the Council consent to its retention. In an important street used for carriage traffic, situated at a greater distance than 2 miles from St. Paul's Cathedral, the Council may lay down a greater prescribed distance, up to a maximum of 30 feet. In the cases specified in Section 15, the Council must pay compensation for any loss sustained by owners of land or buildings on account of this requirement. Any person proposing to build in a street in which a greater prescribed distance has been specified by the Council may appeal to the Tribunal of Appeal. This requirement as to increased prescribed distance has hardly ever been put in force by the Council.

27. Consent to Erection Within Prescribed Distance.—It is provided in Section 13 that the Council, in any case where they think it expedient, may consent to the erection or extension of any building, structure, or forecourt at a distance less than the prescribed distance from the centre of the roadway. Any person dissatisfied by the determination of the Council as regards any such matter may appeal to the Tribunal of Appeal.

28. Re-erection of Certain Buildings. — Subsection 5 of Section 13 admits of the erection of buildings within the prescribed distance on certain old sites. It is there provided that a person may alter or re-erect a building or structure which existed within the prescribed distance either at the commencement of the Act of 1894 or at any time within 7 years previously, if, before commencing the work, he has a plan prepared and gets this certified by the district surveyor. If the building ceased to

exist before the commencement of the Act or has since been accidentally destroyed, the plan is to be the best available under the circumstances of the case. If the district surveyor will not certify the plan, application may be made to the Tribunal of Appeal, who, if reasonably satisfied as to its accuracy, may certify. It was held in 1903, in the case of London County Council *v.* Patman & Fotheringham, that the plan that must be certified by the district surveyor under this section is a ground plan only, showing the extent of the building and the extent of the forecourt. It has been held by the Courts in several cases that the new buildings to be erected need not be similar either in size or number to those originally on the site, provided that no greater area within the prescribed distance is occupied by buildings.

29. Height of Working-Class Dwellings.—There is a proviso to the foregoing provisions which has reference to working-class dwellings. This is as follows :

> Provided always that no dwelling house to be inhabited or adapted to be inhabited by persons of the working class shall, without the consent of the Council, be erected or re-erected within the prescribed distance to a height exceeding the distance of the front or nearest external wall of such building from the opposite side of such street, and that no building or structure shall be converted into such dwelling house within the prescribed distance so as to exceed such height.

Working-class dwellings erected by a local authority previous to the passing of the Act of 1894 may, however, be re-erected. The requirement in Section 13 as to the limitation of the height of working-class dwellings within the prescribed distance applies without modification in the City of London ; but in the application of this requirement throughout the rest of London the words " 20 feet from the centre of the roadway " take the place of the words " prescribed distance " whenever such words occur. The provisions of Section 13 of the London Building Act, 1894, have been amended to this effect by Section 4 of the London Building Acts Amendment Act, 1898.

30. Buildings Within Prescribed Distance of Ways. — Sections 16 and 17 of the Act of 1894 deal with the question of the erection of buildings within the prescribed distance from the

centre of the roadway of ways. This question is not of very great importance, for there is no direct restriction as to the erection of buildings within the prescribed distance from the centre of a way. But it is provided that where, since the commencement of the Act, a building or structure has been erected so as to be within the prescribed distance from the centre of a way, or so as to have its forecourt fence or boundary within the prescribed distance, the way may not become a highway until a written notice has been served on the Council, and until, if required by the Council, any building, or structure, or forecourt fence or wall has been set back so as not to be within the prescribed distance. The Council may, however, sanction the erection of a new building or structure within the prescribed distance from the centre of a way subject to such terms as they may think fit.

LINES OF BUILDING FRONTAGE

DEFINING THE BUILDING LINE

31. It should be especially noted that Part III of the Act of 1894, which has reference to lines of building frontage, does not apply in the City of London. The principal section in this part is Section 22, which consists of two subsections; the first prohibits the erection of buildings in advance of the general line of buildings unless this line is well set back from the roadway, and the second allows the erection of buildings on certain old sites. The text of the first subsection is as follows:

No building or structure shall, without the consent in writing of the Council, be erected beyond the general line of buildings in any street, or part of a street, place, or row of houses in which the same is situate, in case the distance of such line of buildings from the highway does not exceed 50 feet, or within 50 feet of the highway when the distance of the line of buildings therefrom amounts to or exceeds 50 feet, notwithstanding there being gardens or vacant spaces between the line of buildings and the highway.

Such general line of buildings shall, if required, be defined by the superintending architect by a certificate, such certificate to be issued within 1 month from the date of the application therefor.

32. It is provided in Section 24 that the superintending architect shall, within 14 days of the issue of his certificate defining the general line of buildings in any street, cause a notice of his certificate to be served on the local authority, on the owner of the building on the land to which the certificate relates, and on the owner of the houses in the same block or row within a distance not exceeding 50 yards on either side of the said building or land, or if there is no such block or row on the owner of the adjoining land on either side. Section 25 provides that any person who objects to the certificate of the superintending architect may appeal to the Tribunal of Appeal.

33. Erection of Buildings on Old Sites.—The provisions of Subsection 2 of Section 22 of the Act of 1894, which admit of the erection of buildings on certain old sites, are as follows :

> This section shall not apply to any building or structure erected after the commencement of this Act upon land which, either at the commencement of this Act or at any time within 7 years previously, has or shall have been lawfully occupied by a building or structure.

It was held, in 1900, in the case of Scott *v.* Carritt, that a building erected under a licence granted by the Metropolitan Board of Works, a body who were abolished and replaced by the London County Council in 1889, did not lawfully occupy the site on which it stood, so as to admit of its being re-erected to an increased height without the consent of the Council. The legal meaning of the words *lawfully occupied* is thus, in this respect, different to the meaning which would otherwise apply.

34. General Provisions.—Section 26 of the Act of 1894 provides that, in giving their consent to the erection of any building or structure in advance of the general line of buildings, the Council may attach conditions to the effect that the land in front of the building or structure is to be dedicated and left open for the use of the public, or that the building or structure is to be used only for some specified purpose, and generally any other condition which the Council may think fit to impose in the public interest. A consent by the Council to the erection of a building or structure in advance of the general line of buildings is not to be deemed to alter the general line

of buildings as existing at the time of such consent. Where any building or structure which projects beyond the general line of buildings in a street, or beyond the front of the building wall or railing on either side, is taken down to an extent exceeding one-half its cubical extent, the Council may require it to be set back. Compensation must then be paid to the owner, and the amount of such compensation, if not agreed on between the Council and the owner, is to be settled by arbitration. The superintending architect may be required to certify in which street or streets a building or structure is situate, and an appeal may be made to the Tribunal of Appeal against his certificate. A house at the corner of two streets is usually considered, however, to front to both streets, and consequently to be governed by the general line of buildings in both streets.

OPEN SPACES ABOUT BUILDINGS

SPACE AT REAR

35. Varied Definitions of Domestic Building.—The requirements in the Act of 1894 relating to open spaces about buildings are contained in Part V. It should be noted that the definition of *domestic building* is specially varied for the purpose of this part of the Act. The provisions of Section 39 are as follows :

> For the purposes of this part of this Act, the expression *domestic building* shall not include any buildings used, or constructed or adapted to be used, wholly or principally as offices or counting houses.

36. Open Space for Habitable Basement.—The first requirement as to open space has reference to the lighting and ventilation of habitable basements. The provisions of Section 40 of the Act of 1894 are as follows :

> In the case of domestic buildings, erected after the commencement of this Act, which shall have a habitable basement, there shall, for the purpose of giving light and air to such basement, be provided in the rear of the building and exclusively belonging thereto, an open space of an aggregate extent of not less than 100 square feet, free from any erection thereon above the level of the adjoining pavement, which open space, notwithstanding anything hereinafter contained, need not necessarily adjoin the rear boundary of the premises.

In order to ascertain whether this requirement applies in any doubtful case, it will be necessary to refer to the definition of the term *habitable* and the definition of the term *basement story*, both of which are given in Section 5. It is worthy of notice that the open space required by Section 40 need not adjoin the rear boundary of the premises.

37. Open Space at Rear of Buildings.—The requirements of Section 41 of the Act of 1894, which deal with the provision of open space at the rear of domestic buildings and the limitation of the height of the rear portions of such buildings by means of a statutory diagonal line, are very complex. The section deals with two main cases: where buildings abut on streets formed after the commencement of the Act and where buildings abut on streets formed before the commencement of the Act

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BUILDINGS IN STREETS FORMED AFTER JANUARY 1, 1895

38. Open-Space Requirements. — The ordinary open-space requirements with regard to domestic buildings abutting on streets laid out after the commencement of the Act of 1894 are as follows:

There shall be provided, in the rear of every such building, an open space exclusively belonging to such building, and of an aggregate extent of not less than 150 square feet.

Where there is a basement story directly and sufficiently lighted and ventilated by the open space provided under the preceding section, irrespective of any use to which the ground story is appropriated, or where there is no such basement story, but where the ground story is not constructed or adapted to be inhabited, the open space required by this section may be provided above the level of the ceiling of the ground story, or a level of 16 feet, exclusive of lantern lights, measured from the level of the adjoining pavement.

In all other cases the open space shall be free from any erection thereon above the level of the adjoining pavement, except a water-closet, earth-closet, or privy, and a receptacle for ashes, and enclosing walls, none of which erections shall exceed 9 feet in height.

Such open space shall extend throughout the entire width of such building, and to a depth in every part of at least 10 feet from such building.

39. The minimum area and minimum depth of the open space are the same in either case, but the level at which the open

space must be provided depends on whether there is a basement story sufficiently lighted and ventilated by the open space provided in accordance with the provisions of Section 40, or whether, when there is no basement, the ground story is or is not constructed or adapted to be inhabited. If there is no such basement story, and the ground story is constructed or adapted to be inhabited, the open space must be provided at the level of the adjoining pavement of the street. If, however, the circumstances are the reverse, the open space need not be provided below the level of the ceiling of the ground story or below 16 feet from the level of the adjoining pavement; that is, the whole site, other than any space required for the ventilation of a habitable basement, may be covered by the buildings up to the higher of such two levels.

40. **Diagonal-Line Requirements.**—In addition to the open-space regulations, the height of the rear portions of domestic buildings is limited by means of a **diagonal line.** The text of the ordinary diagonal-line requirements is as follows:

An imaginary line, hereafter referred to as *the horizontal line*, shall be drawn at right angles to the roadway formed or to be formed in front of the building, and through or directly over a point in front of the centre of the face of the building.

The horizontal line shall be produced to intersect the boundary of the open space furthest from the said roadway.

The horizontal line shall be drawn throughout at the level of the pavement formed or to be formed in front of the centre of the building, unless the site of the building incline toward the roadway or site of the roadway, in which case the horizontal line shall be drawn directly over the said point, in front of the centre of the face of the building, at the level throughout of the ground at the boundary of the space furthest from such roadway where such boundary is intersected by the horizontal line.

A second imaginary line, in this part of this Act called *the diagonal line*, shall be drawn in the direction of the building above and in the same vertical plane with the horizontal line, and inclined thereto at an angle of $63\frac{1}{2}°$, and meeting the horizontal line where it intersects the boundary of the space furthest removed from such roadway.

No part of such building shall extend above the diagonal line, except chimneys, dormers, gables, turrets, or other architectural ornaments aggregating in all to not more than one-third of the width of the rear elevation of such building, and except any building which, under the provisions of this section, is permitted on the open space.

41. The horizontal line determines, in common language, the level at which the diagonal line is required to be commenced to be drawn. This is that of the pavement in front of the centre of the building, except where the site slopes down to the roadway. In that case, the level at which the horizontal line is to be drawn is the actual level of the ground at the point where the rear boundary of the site is intersected by the horizontal line.

42. Sloping Ground and Unsymmetrical Sites.—Special provisions apply in connection with the drawing of the diagonal line in cases when the pavement of the street is not level and when the boundaries of the space at the rear are not regular. It is provided that :

When the pavement in front of a building is not all on one level, then, for the purpose of compliance with this section, the mean level of such pavement shall be deemed to be the level thereof. And where the boundary of the space at the rear of such building is not parallel with the rear wall of the building, then, for the purpose of this section, the horizontal line shall be drawn to a point distant from such rear wall the mean distance from such wall of the boundary of the space at the rear of such building, whether such point be beyond the said boundary or not.

When the boundary of the space at the rear of any such building shall be so irregular in shape that a doubt arises as to how the measurement shall be taken, application shall be made to the Council, and the applicant, if dissatisfied with the determination of the Council, may appeal to the Tribunal of Appeal.

43. Street or Open Space at Rear.—Obviously, when the site of a building abuts at the rear on a street or open space which cannot be built upon, it would be absurd to enforce the ordinary open-space provisions. This is recognized and dealt with as follows :

When the land at the rear of any such building, and exclusively belonging thereto, abuts immediately upon a street, or upon an open space which is dedicated to the public, or the maintenance of which as an open space is secured permanently or to the satisfaction of the Council by covenant or otherwise, the horizontal line shall be produced and the diagonal line may be drawn from the horizontal line at the centre of the roadway of such street at the level of the surface thereof, or at the further boundary of such open space, and it shall not be necessary to provide any open space at the rear of such building.

44. Corner Buildings.—The following provisions apply to the case of corner buildings:

The Council may

(*a*) In the case of a building at a corner abutting upon two streets;

(*b*) In the case of a building at a corner abutting on one side upon a street and on another side upon an open space not less than 40 feet wide at any part, the maintenance of which as an open space is secured, permanently or to the satisfaction of the council, by covenant or otherwise;

permit the erection of buildings not exceeding 30 feet in height upon such part of the space in the rear as they may think fit, provided that the Council be satisfied that such buildings shall be so placed as not to interfere unduly with the access of light and air to neighbouring buildings.

When the Council refuse any application under this subsection for permission to erect a building not exceeding 30 feet in height upon the space at the rear, the applicant, if dissatisfied with the determination of the Council, may appeal to the Tribunal of Appeal.

In the case of buildings at a corner as hereinbefore described, nothing in this part as to the determination of height by the diagonal line shall prevent the return front of such buildings being carried up to the full height of the front elevation for a distance of 40 feet, or for such less distance as the requirements for open space at the rear may demand.

45. Exceptional Cases.—It is provided that in exceptional cases, where, owing to the irregular shape of the land, any of the provisions either as to space at the rear or the diagonal line cannot be applied, the Council may allow such modifications as they may think fit. Any person interested who is dissatisfied with any determination of the Council, with regard to an application for special treatment, may take the matter to the Tribunal of Appeal.

BUILDINGS IN STREETS FORMED BEFORE JANUARY 1, 1895

46. The requirements affecting both the question of open space at the rear, and that of the height of the rear portions of buildings, are less stringent when a building abuts on a street formed before the commencement of the Act of 1894. It is provided that:

With respect to domestic buildings erected after the commencement of this Act, abutting upon a street formed or laid out before the commencement of this Act, the provisions of this section shall apply with this modification, that the horizontal line shall be drawn throughout at a level of

16 feet above the level of the adjoining pavement, and that, in any such case, except in the case of dwelling houses to be inhabited or adapted to be inhabited by persons of the working class, the open space to be provided in accordance with paragraphs i and ii of Subsection 1 of this section may be provided above the level of the ceiling of the ground story, or above a level of 16 feet, exclusive of lantern lights, above the level of the adjoining pavement.

The open-space requirements contained in paragraphs i and ii of Subsection 1 are those quoted in Art. 38. The open space is required to be of similar area and depth to that specified in the case of buildings abutting on streets formed after the commencement of the Act. The diagonal line is also drawn at a similar angle. It is only the level at which the open space is to be provided and the diagonal line drawn that are altered, and the alteration of level in the provision of open space occurs only in the case of buildings which are not dwelling houses to be inhabited or adapted to be inhabited by persons of the working class.

GENERAL AIR-SPACE PROVISIONS

47. Equivalent Cubic Air Space.—There are two provisions which modify and limit the scope of the ordinary requirements of Section 41 of the Act of 1894. These take effect without reference to the age of the street on which a building abuts. The first of these admits of a deviation from the ordinary diagonal-line requirements; the text of this is as follows:

Provided always that, notwithstanding the preceding provisions of this part of this Act, any part of any domestic building may extend above the diagonal line, provided that the Council or Tribunal of Appeal shall be satisfied that an open cubic space of air will be provided at the rear of such building, equivalent to the open cubic space which would have been provided at the rear of such building, if such diagonal line had been drawn from the ground level in manner provided in Subsection 1 (iii) of this section, and if no part of such building, except as permitted under the preceding provisions of this section, had extended above such diagonal line. The applicant, if dissatisfied with the determination of the Council, may appeal to the Tribunal of Appeal.

The provisions of paragraph iii, Subsection 1, are those having reference to the limitation of the height of the rear portion of a domestic building by means of the diagonal line.

48. Buildings Exempt From Section 41.—The second of the provisions which limit the scope of Section 41 of the Act of 1894 states that buildings in certain situations are exempt from the provision of the section:

> Nothing in this section shall apply to houses abutting in the rear on the River Thames, or on a public park, or on an open space of not less than 80 feet in depth which is dedicated to the public or the maintenance of which as an open space is secured permanently, or to the satisfaction of the Council, by covenant or otherwise.

49. Front of a Building.—Section 46 of the Act of 1894 provides that, in any case when it may be necessary, the superintending architect shall determine which is the front and which is the rear of a building, and that such determination is to be evidenced by his certificate.

DIAGRAMS ILLUSTRATING OPEN-SPACE REQUIREMENTS

50. Diagrams of Buildings Abutting on New Streets.—In order that there may be no uncertainty as to the application of the requirements of the Act of 1894 that deal with open spaces at the rear of buildings, several diagrams are given; but these diagrams must be considered in conjunction with the text of the Act. In Fig. 1 is shown the open space required at the rear of a domestic building abutting on a street formed after the commencement of the Act. The building is situated, in the first case (*a*) on a level site, and in the second case (*c*) on a site sloping toward the roadway. The horizontal line *a* and diagonal line *b* are shown in either case by dot-and-dash lines. A section of the building as erected on a level site *c d* is shown in (*a*) and a plan in (*b*). In such case, the open space is provided at the level of the pavement of the street, and the horizontal line is drawn at this level. The building as erected on a site *c d* sloping to the roadway is shown in section in (*c*) and in plan in (*d*). In this case, the open space is provided at the level *c* of the ground, and the horizontal line is drawn at the level of the ground at the rear boundary. In both examples the water-closet, which is permitted by the Act to be placed on the open space, is shown at *e*. In both examples the sectional view shows that the building is constructed to the full

limits permitted by the diagonal-line requirements. This, of course, will not be done in practice, but the rear portion of the building will be formed with set-backs occurring at the floor levels, as shown by the dotted lines in Fig. 1 (*a*), which lines represent the walls and flat roofs of the rear portion of the building.

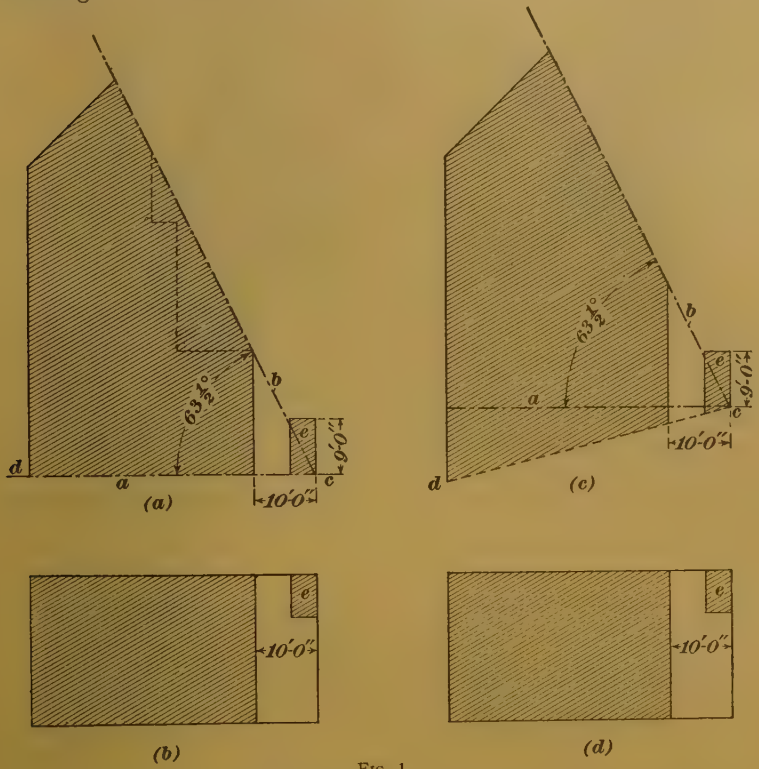


FIG. 1

51. Diagrams of Buildings With Habitable Basements.—In Fig. 2 are shown two buildings that abut on a street laid out after the commencement of the Act of 1894, but each building has a habitable basement, which is considered to be lighted and ventilated directly and sufficiently by the open space required by Section 40. In one case (*a*), the building is erected on a level site *g h*; in the other (*c*), the site *g h* slopes to the roadway. The open space of 100 square feet provided for the

purpose of ventilating the basement is shown at *c d e f* in the plans (*b*) and (*d*); in each case *a* is the horizontal line and *b* the diagonal line. The portion of the building which, owing to the provision of this open space, does not extend across the full width of the site is denoted in the sections (*a*) and (*c*) by light

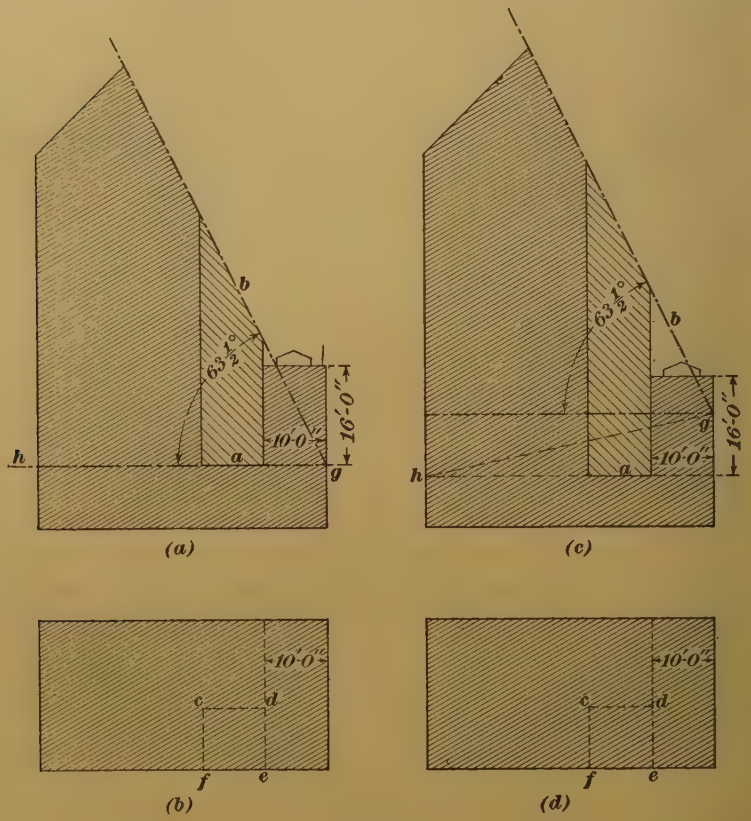


Fig. 2

hatching, with the lines running in the reverse direction to those in the remaining portions of the diagrams.

52. In both cases shown in Fig. 2, the open space at the rear is not required until a level of 16 feet above the adjoining pavement has been reached. Thus, in both cases, with the exception of the area *c d e f*, the whole site is built over to a level of 16 feet

above the pavement. Above this level the building is set back 10 feet from the rear boundary in order to provide the required open space. The level at which the horizontal line is drawn varies, as in the examples shown in Fig. 1, in accordance with the character of the site. When the site is level, as shown in (*a*), the horizontal line *a* is drawn at the pavement level. When the site *g h* slopes toward the roadway, as shown in (*c*), the horizontal line *a* is drawn at the level of the ground *g* at the rear boundary of the site. The diagonal line *b* is drawn at an angle of $63\frac{1}{2}^\circ$ with the horizontal line.

53. Uninhabited Ground Story.—Where there is no basement, and the ground story is not constructed or adapted to be inhabited, the open space to be provided will be exactly the same as that shown in Fig. 2, except that, as there is no basement, no open space will be required for basement ventilation, and thus the whole site may be built upon to a level of 16 feet above the pavement. In all cases of buildings abutting on streets formed after the commencement of the Act of 1894, the horizontal line must be drawn at the pavement level if the site is level or if it slopes down from the roadway. It is only when the site slopes down toward the roadway that the horizontal line is required to be drawn at the level of the ground at the rear boundary of the site.

54. Diagrams of Buildings Abutting on Old Streets.—The requirements of the Act of 1894 as to the provision of open space about buildings abutting on streets formed before the commencement of the Act do not vary in accordance with whether or not there is a properly ventilated basement or whether or not, when there is no basement, the ground story is constructed or adapted to be inhabited. They vary only in accordance with whether or not the buildings are of ordinary or of working-class character. In Fig. 3, two cases are shown. View (*a*) is a section and (*b*) a plan of an ordinary building; (*c*) is the section and (*d*) the plan of a dwelling house to be inhabited by persons of the working class. In (*a*) and (*b*) the open space is provided above the level of 16 feet from the adjoining pavement; in (*c*) and (*d*) the open space is provided at the pavement level. In each case

a is the horizontal line; *b*, the diagonal; *c*, the pavement level; *d*, the water-closet which, in the latter case, it is permissible to build on the open space.

55. Although the Act of 1894 is not too clear on the point, it would appear that, where a working-class dwelling abutting on a street formed before the commencement of the Act has

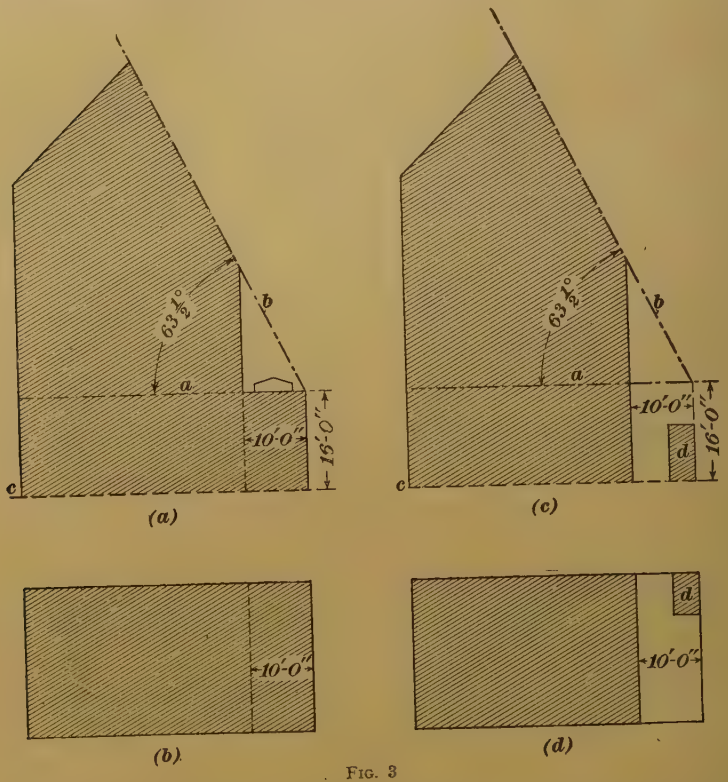


FIG. 3

a habitable basement properly ventilated and lighted by the open space required by Section 40, the open space at the rear may be provided above a level of 16 feet from the adjoining pavement. In the case both of the ordinary building and the working-class dwelling shown in Fig. 3, the horizontal line *a* is drawn at a level of 16 feet above the level *c* of the adjoining pavement. Cases of buildings on sloping sites are not shown,

for the question of whether or not a site is level is immaterial when a building abuts on a street formed before the commencement of the Act. In all buildings abutting on such streets the horizontal line must be drawn at a level of 16 feet above the level of the adjoining pavement.

56. Notes Regarding the Diagrams.—In Figs. 1 to 3, the open space at the rear is shown to have a depth of 10 feet, which is the minimum specified by the Act. In the case of a building having a frontage less than 15 feet in length, it will be necessary to increase the depth of the open space so that the area of the space will not be below the specified minimum of 150 square feet. The open space *c d e f* provided for basement ventilation in Fig. 2 need not be in the position shown. All that the Act requires is that it is provided somewhere in the rear portion of the building. In many cases, it will be desirable to provide the space immediately adjoining the rear boundary.

In the references which have been made to the provision of an open space at a level above that of the pavement, and the drawing of the horizontal line at such higher level, the level has been both quoted and shown as being 16 feet above the pavement. But the Act permits the governing level, for the provision of air space, but not the drawing of the horizontal line, to be the level of the ceiling of the ground story, which, however, is usually less than 16 feet above the pavement.

SPECIAL OPEN-SPACE REQUIREMENTS

57. Domestic Buildings on Old Sites.—The provisions of the Act of 1894 with regard to open spaces about buildings are specially modified in three instances ; in the case of (*a*) domestic buildings erected on certain old sites, (*b*) dwelling houses for the working classes not abutting on a street, and (*c*) buildings erected on land which has been cleared of buildings, and the streets re-arranged. Section 43 provides that, when a person intends to erect a domestic building on the site of domestic buildings existing at the commencement of the Act, or on a site which was occupied by a domestic building at any time within

7 years previous to the commencement of the Act, if such person has plans prepared showing the extent of the previously existing building and gets these certified by the district surveyor he may erect the new building to the same lines. Dwelling houses for the working classes are specially excluded from the provisions of this section. If it is desired to erect the new building of a larger size than the existing building, the consent of the Council must be obtained. Any person dissatisfied with a determination of a district surveyor or of the Council under this section may take the matter to the Tribunal of Appeal. It was held, in 1898, in the case of Paynter *v.* Watson, that the plans to be certified must be a complete set of plans, so as to show the extent of the building on the several floors, and that, if a person desires to deviate in any respect from the lines of the old building, he must obtain the consent of the Council to the deviations proposed.

58. Dwellings not Abutting on Street.—Section 42 of the Act of 1894 provides that when a person desires to erect a dwelling house to be inhabited or adapted to be inhabited by persons of the working class, not abutting on a street, he must submit plans to the Council showing the extent and height of the building in its several parts. Within 1 month from the date of the receipt of the plans the Council, if they are of opinion that a sufficient open space or spaces for the admission of light and air will not be provided, may refuse to sanction the plans. Should the Council not disapprove the plans within 1 month after their receipt, they will be considered to have given their sanction. The Council have not, however, unrestricted power of refusal, for it is provided that they may not refuse to sanction the plans in any case where the open space proposed to be provided is equivalent to the open space which would have been provided under the requirements of the Act if the dwelling house had been erected abutting on a street formed before the commencement of the Act. Any person who is dissatisfied with a decision of the Council under this section may appeal to the Tribunal of Appeal.

59. Erection of Buildings on Cleared Area.—Section 44 of the Act of 1894 provides that when a person desires to re-arrange

a cleared area formerly occupied in whole or in part by buildings, by forming new streets or widening existing streets, he may make application with plans and sections to the Council, and the Council, at their discretion, may modify or relax any of the provisions of the Act having reference to open spaces about buildings. The Council must either sanction or disapprove the plans within 2 months from the date of the receipt of such plans. If they do not give notice of their disapproval within such period, they will be deemed to have given their consent. Any person dissatisfied with the Council's determination under this section may take the matter to the Tribunal of Appeal.

COURTS WITHIN A BUILDING

60. Ventilation of Certain Enclosed Courts.—The ventilation of the air space contained within certain enclosed courts is required by the first part of Section 45 of the Act of 1894. It is provided, where a court wholly or in part open at the top, but enclosed on every side, is constructed in connection with a domestic building, and the depth of the court measured from the eaves or top of the parapet to the ceiling of the ground story exceeds the length or breadth, that adequate provision for the ventilation of the court must be made by means of a communication between the lower end of the court and the outer air.

61. Light and Air for Habitable Rooms.—The second portion of Section 45 of the Act of 1894 prohibits the construction of a habitable room lighted only from a court, unless the height of the wall on the opposite side of the court is limited so that such a room obtains a reasonable amount of light and air. The requirements, which are in two parts, dealing with courts enclosed on all sides and with certain courts open on one side, are as follows:

No habitable room not having a window directly opening into the external air, otherwise than into a court enclosed on every side, shall be constructed in any building unless the width of such court, measured from such window to the opposite wall, shall be equal to half the height, measured from the sill of such window to the eaves or top of the parapet of the opposite wall.

Provided that a court, of which the greater dimension does not exceed twice the less dimension, shall be held to comply with this section if a court of the same area, but square in shape, would comply therewith.

No habitable room above the level of the ground story not having a window directly opening into the external air, otherwise than into a court open on one side, the depth whereof measured from the open side exceeds twice the width, shall be constructed in any building unless every window of such room be placed not nearer to the opposite wall of such court, or to any other building, than one-half the height of the top of such wall or building above the level of the sill of such window.

62. Application of Requirements. — The application of the requirements as to the amount of light to be provided to the windows of habitable rooms which are not lighted otherwise than from a court of a kind referred to in Section 45 is shown in Fig. 4. The requirements applying to habitable rooms lighted from a court enclosed on all sides are complied with in (*a*) and (*b*), which are, respectively, a section through and a plan of such a court. In (*a*), the wall on the side of the court opposite that in which the windows occur is not carried up to a greater height measured from the level of the sill of the lowest window than twice the width of the court at such level; that is, the distance *a c* in (*a*) is not more than double the distance *a b*. It is, however, provided that a court whose greater dimension does not exceed twice its lesser dimension will be satisfactory if a square court of the same area will comply with the requirement. This allows the height of the wall opposite the windows to be increased in height, as shown in (*a*) by the dotted lines. This limit of height is obtained by constructing a square court of the same area as the actual court, as shown by the dot-and-dash lines in (*b*), constructing a section through that court as shown in (*a*), and making the height *d e* not more than twice the distance *d b*. If the court were square and of a width equal to *d b*, it would be possible to erect a wall opposite the windows to the level *e*. Therefore it is admissible to extend the wall *a c* to this height, as shown at *e'*.

63. The case of a court open on one side, and having a depth that exceeds twice the width, is shown in section and plan in (*c*) and (*d*). The requirements in this case are similar to those that apply to a wholly enclosed court, with the two

important exceptions that there is no proviso that compliance will be considered as effected if a square court of equal area would comply, and that the rule as to the measurement of

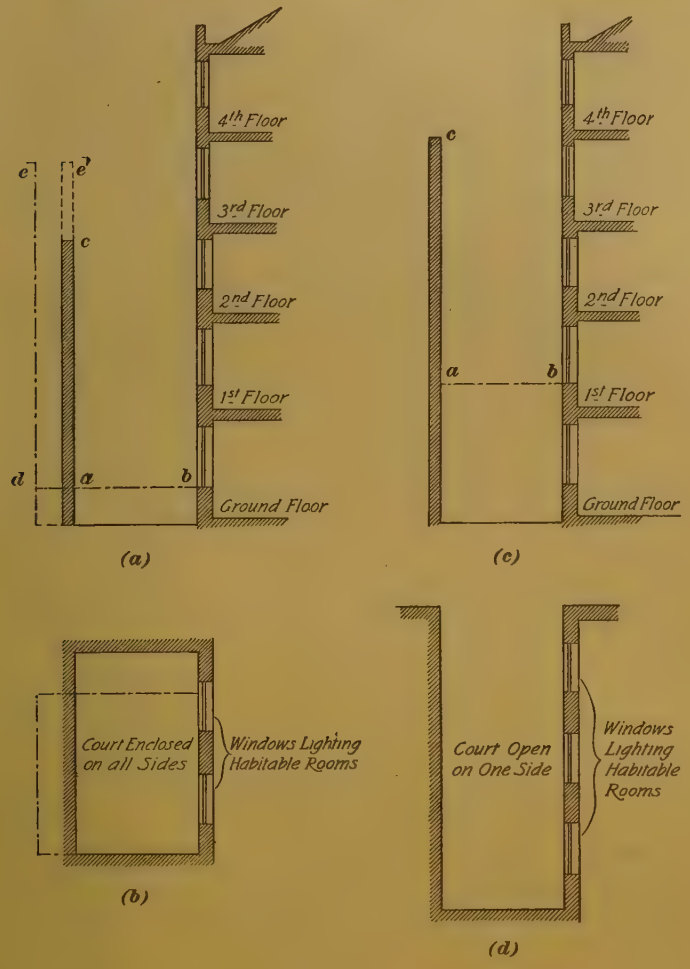


Fig. 4

height from window sills applies only to windows above the ground story. Thus, the measurement in Fig. 4 (*c*) is taken from the level of the first-floor window sills, and the distance *a c* is made twice the distance *a b*, which gives the point *c* as the

greatest height to which it is possible to erect the wall on the side of the court opposite the windows lighting the habitable room or rooms.

BUILDINGS WITH STABLES IN THE REAR

64. Modification of Open-Space Requirements.—The ordinary requirements of Part V of the Act of 1894 with regard to the provision of open spaces about buildings are specially modified in the case of domestic buildings that have stables in the rear, if the total depth of the site and the depth and height of the stable are not greater than certain specified figures. Section 52 of the Act, which contains such provisions, is as follows :

In the case of domestic buildings, and buildings erected or adapted for use as stables, such domestic buildings and such stable buildings being upon sites abutting in the front upon a street and in the rear upon mews, and such sites being of a depth of not more than 150 feet, measured from street to mews, the following provisions shall in certain cases have effect :

If the stable buildings be limited to a depth of 50 feet, measured from the mews frontage, and to a height of 25 feet, measured from the level of the mews, and if the open space required for the domestic building under Section 41 of this Act be provided between the domestic building and the stable building, the domestic building and the stable building may, for all other purposes of the said section, whether in one occupation or not, be deemed to be one domestic building with the rear abutting upon a street.

HEIGHTS OF BUILDINGS

REQUIREMENTS IN ORDINARY STREETS

65. General Limit of Height.—The height of the great majority of buildings in London is controlled by Section 47 of the Act of 1894. This provides that a building, not being a church or a chapel, shall not, without the consent of the Council, be erected to, or be subsequently increased to, a greater height than 80 feet, exclusive of two stories in the roof and of ornamental towers, turrets, or other architectural features or decorations. It is provided, however, that this requirement is not to apply to the re-erection, to the same height, of a building existing at the passing of the Act and having a greater height than 80 feet.

In order to understand the exact scope of this requirement, the definition of *height* given in Section 5 should be studied. It will be seen that the measurement of height varies according to whether a wall is finished with a parapet or gable.

66. Notice and Rights of Appeal.—Section 48 of the Act of 1894 provides that when the Council consent to the erection of any building of a greater height than 80 feet, notice of the consent must be published and served in such manner as the Council may direct. The consent is not to be acted on until the expiration of 21 days from the date of publication. Within 21 days from the date of publication of a consent, or from the date of a refusal of consent, the owner or lessee of any building or land within 100 yards of the proposed building, or an applicant for a consent which has been refused, as the case may be, has the right to appeal to the Tribunal of Appeal. In the case of an appeal against a refusal of consent, any owner or lessee of any building or land within 100 yards of the site of the intended building may appear and be heard before the Tribunal of Appeal when the case is under consideration by that body.

REQUIREMENTS IN CERTAIN MODERN STREETS

67. Streets Formed Since 1862.—Section 49 provides, in the case of streets formed since August 7, 1862, and of a less width than 50 feet, that, except with the consent of the Council, no existing building abutting on such a street, other than a church or a chapel, may be raised, and no new building erected, to a height greater than the distance of its front or nearest external wall from the opposite side of the street. Where a building is erected on a corner plot so as to abut on two streets, it is provided that the height of the building is to be regulated by the wider street for the length of the frontage of the building to such street, and that the main elevation of the building is allowed to be carried, without alteration of height, for a distance of 40 feet along the narrower street. The height of the building, for the rest of its frontage to the narrower street, is then regulated by the width of such narrower street.

REQUIREMENTS AS TO CONSTRUCTION

CONSTRUCTION OF ORDINARY PERMANENT BUILDINGS

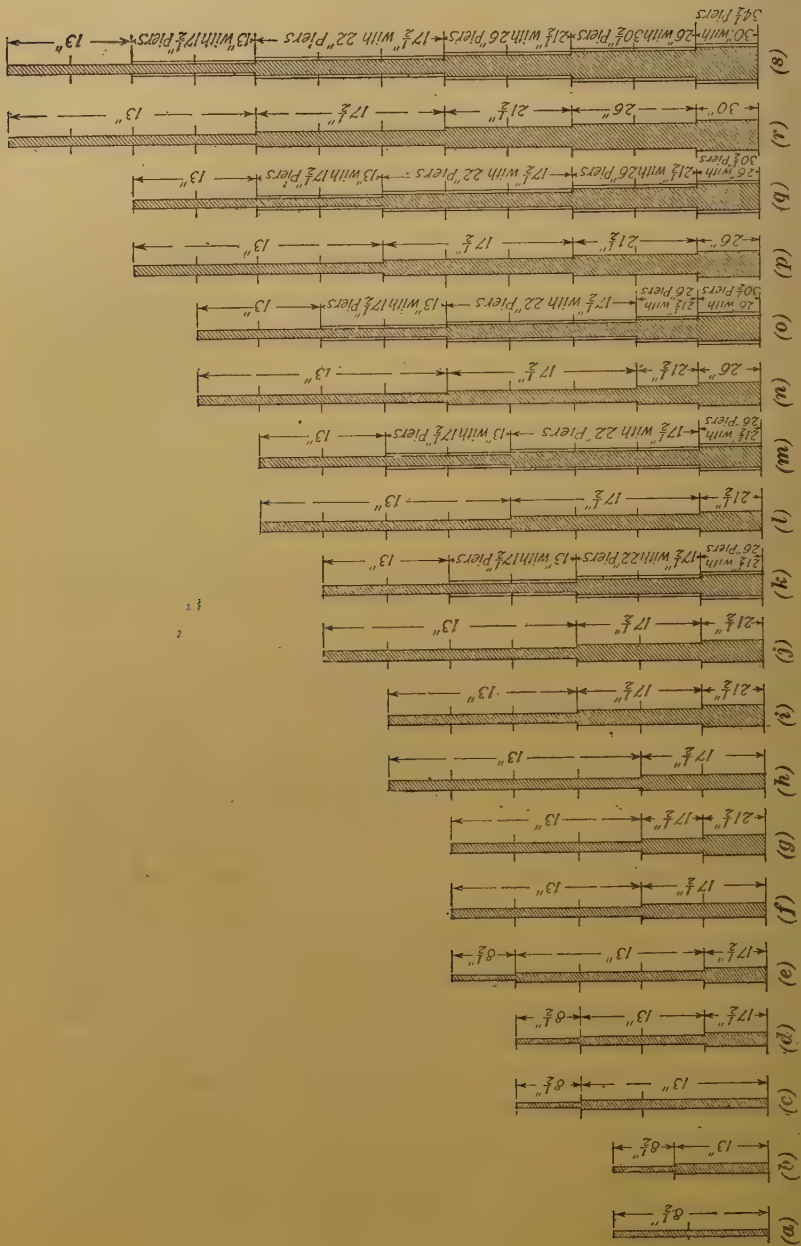
68. Parts of Act Dealing With Construction.—The principal requirements of the Act of 1894, with regard to the construction of buildings, are contained in Parts VI and VII. The provisions of Part VI deal with permanent buildings, and those of Part VII with special and temporary buildings and structures, which can be erected only by special consent. The First Schedule of the Act, which deals with the materials used in the construction of walls, and specifies the thickness of walls in accordance with their height and length and the class of buildings in which they occur, may be considered as an appendage to Part VI; for it is provided in Section 53, the first section which occurs in Part VI, that walls are to be constructed of the substances, and in the manner, and of not less than the thickness prescribed by the Act or mentioned in the First Schedule to the Act.

69. General Constructional Rules.—There are several constructional rules in the Preliminary to the First Schedule of the Act of 1894. Every building must be enclosed with walls constructed of bricks, stone, or other hard incombustible substance, except open sheds that do not exceed 16 feet in height nor 400 square feet in area; these may be constructed of any substance and in any manner that may be approved by the district surveyor. The requirements in the schedule with regard to the thickness of walls apply to walls built of bricks, stone, or other blocks of hard incombustible substance laid in horizontal beds or courses. Walls built of other materials and not laid in horizontal beds or courses must be one-third thicker. No part of any wall may overhang any part underneath it for more than 6 inches, and this projection is allowable only when the projection is solidly corbelled out, and the side of the wall opposite the corbelling is carried up vertically in one straight face. When hollow walls are constructed, a wall on one side of the hollow space must be of the full thickness prescribed by

the Act. Every wall other than a wall carried on a bressummer must have footings. All underpinning to walls and chimneys must be executed in cement. Any work of thickening a wall must be carried out in cement and properly bonded to the old work, and no such thickening of a wall may be carried out until notice has been given to the district surveyor.

70. Rules as to Measurement.—Several important rules as to measurement occur in the Preliminary to the First Schedule. It is provided that the height of every story, other than a topmost story, is to be measured from the level of the under side of the floor joists of such story to the level of the under side of the floor joists of the story immediately above. The height of a topmost story is to be measured from the level of the under side of its floor joists to the level of the under surface of the tie of the roof, or, if there is no such tie, to half the vertical height of the rafters. The height of a wall must be measured from the base of the wall to the top of the topmost story without reference to whether or not the wall is actually carried to this height, or, in the case of a gable, when there are no stories in the roof, to half the height of the gable. Reference should be made to the definition of base, which is given in Section 5 of the Act of 1894. Walls are supposed to be divided into distinct lengths by return walls, which must be external party or cross-walls, properly bonded with such walls. The length of a wall is to be measured from the centre of one return wall to the centre of another.

71. Rules as to Thickness of Walls.—The rules for the thickness of external and party walls in all buildings other than public buildings are given in Parts I and II of the First Schedule to the Act of 1894. Cross-walls must be two-thirds the thickness of external and party walls of the same height and length. Part I of the schedule deals with the class of buildings, not public nor of the warehouse class, which, for all practical purposes, may be termed domestic buildings. Part II deals with buildings of the warehouse class. There are no rules laid down with regard to the thickness of walls of public buildings, for this question is left to the discretion of the district surveyor who deals with each particular case.


(a)
8½"
(b)
13"
8½"
(c)
13"
8½"
(d)
17½"
13"
8½"
(e)
17½"
13"
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(f)
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13"
(g)
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(h)
17½"
13"
(i)
21½"
17½"
13"
(j)
21½"
17½"
13"
(k)
21½ with 26 piers
17½" with 22 piers
13" with 17½" piers
(l)
21½"
17½"
13"
(m)
21½ with 26 piers
17½" with 22" piers
13" with 17½" piers
(n)
26"
21½"
17½"
13"
(o)
26 with 30½ piers
21½ with 26 piers
17½" with 22" piers
13" with 17½" piers
13"
(p)
26"
21½"
17½"
13"
(q)
26" with 30½ piers
21½" with 26" piers
17½" with 22" piers
13" with 17½" piers
13"
(r)
30"
26"
21½"
17½"
13"
(s)
30" with 34½ piers
26" with 30½ piers
21½" with 26" piers
17½" with 22" piers
13" with 17½" piers
13"

FIG. 5

72. Thickness of Walls for Domestic Buildings.—In Fig. 5 are shown the minimum thicknesses for walls of buildings that are not public and do not belong to the warehouse class. The text of the Act which follows has been lettered to correspond with the letters placed under the various diagrams shown in the illustration :

External and party walls shall be of not less thickness than the thickness hereinafter specified in each case, viz. :

1. When the wall does not exceed 25 feet in height, its thickness shall be as follows :

(*a*) If the wall does not exceed 30 feet in length, and does not comprise more than two stories, it shall be $8\frac{1}{2}$ inches thick for its whole height.

(*b*) If the wall exceeds 30 feet in length, or comprises more than two stories, it shall be 13 inches thick below the topmost story, and $8\frac{1}{2}$ inches thick for the rest of its height.

2. When the wall exceeds 25 feet, but does not exceed 40 feet in height, its thickness shall be as follows :

(*c*) If the wall does not exceed 35 feet in length, it shall be 13 inches thick below the topmost story, and $8\frac{1}{2}$ inches thick for the rest of its height.

(*d*) If the wall exceeds 35 feet in length, it shall be $17\frac{1}{2}$ inches thick for the height of one story, then 13 inches thick for the rest of its height below the topmost story, and $8\frac{1}{2}$ inches thick for the rest of its height.

3. When the wall exceeds 40 feet, but does not exceed 50 feet in height, its thickness shall be as follows :

(*e*) If the wall does not exceed 30 feet in length, it shall be $17\frac{1}{2}$ inches thick for the height of one story, then 13 inches thick for the rest of its height below the topmost story, and $8\frac{1}{2}$ inches thick for the rest of its height.

(*f*) If the wall exceeds 30 feet, but does not exceed 45 feet in length, it shall be $17\frac{1}{2}$ inches thick for the height of two stories, and then 13 inches thick for the rest of its height.

(*g*) If the wall exceeds 45 feet in length, it shall be $21\frac{1}{2}$ inches thick for the height of one story, then $17\frac{1}{2}$ inches thick for the height of the next story, and then 13 inches thick for the rest of its height.

4. Where the wall exceeds 50 feet, but does not exceed 60 feet in height, its thickness shall be as follows :

(*h*) If the wall does not exceed 45 feet in length, it shall be $17\frac{1}{2}$ inches thick for the height of two stories, and 13 inches thick for the rest of its height.

(*i*) If the wall exceeds 45 feet in length, it shall be $21\frac{1}{2}$ inches thick for the height of one story, then $17\frac{1}{2}$ inches thick for the height of the next two stories, and then 13 inches thick for the rest of its height.

5. Where the wall exceeds 60 feet, but does not exceed 70 feet in height, its thickness shall be as follows :

(*j*) If the wall does not exceed 45 feet in length, it shall be $21\frac{1}{2}$ inches thick for the height of one story, then $17\frac{1}{2}$ inches thick for the height of the next two stories, and then 13 inches thick for the rest of its height.

(*k*) If the wall exceeds 45 feet in length, it shall be increased in thickness in each of the stories below the uppermost two stories by $4\frac{1}{2}$ inches, subject to the provisions in this schedule respecting distribution in piers.

6. Where the wall exceeds 70 feet, but does not exceed 80 feet in height, its thickness shall be as follows :

(*l*) If the wall does not exceed 45 feet in length, it shall be $21\frac{1}{2}$ inches thick for the height of one story, then $17\frac{1}{2}$ inches thick for the height of the next three stories, and 13 inches thick for the rest of its height.

(*m*) If the wall exceeds 45 feet in length, it shall be increased in thickness in each of the stories below the uppermost two stories by $4\frac{1}{2}$ inches, subject to the provisions in this schedule respecting distribution in piers.

7. Where the wall exceeds 80 feet, but does not exceed 90 feet in height, its thickness shall be as follows :

(*n*) If the wall does not exceed 45 feet in length, it shall be 26 inches thick for the height of one story, then $21\frac{1}{2}$ inches thick for the height of the next story, then $17\frac{1}{2}$ inches thick for the height of the next three stories, and then 13 inches thick for the rest of its height.

(*o*) If the wall exceeds 45 feet in length, it shall be increased in thickness in each of the stories below the uppermost two stories by $4\frac{1}{2}$ inches, subject to the provision in this schedule respecting distribution in piers.

8. Where the wall exceeds 90 feet, but does not exceed 100 feet in height, its thickness shall be as follows :

(*p*) If the wall does not exceed 45 feet in length, it shall be 26 inches thick for the height of one story, then $21\frac{1}{2}$ inches thick for the height of the next two stories, then $17\frac{1}{2}$ inches thick for the height of the next three stories, and then 13 inches thick for the rest of its height.

(*q*) If the wall exceeds 45 feet in length, it shall be increased in thickness in each of the stories below the uppermost two stories by $4\frac{1}{2}$ inches, subject to the provision in this schedule respecting the distribution in piers.

9. Where the wall exceeds 100 feet, but does not exceed 120 feet in height, its thickness shall be as follows :

(*r*) If the wall does not exceed 45 feet in length, it shall be 30 inches thick for the height of one story, then 26 inches thick for the height of the next two stories, then $21\frac{1}{2}$ inches thick for the height of the next two stories, then $17\frac{1}{2}$ inches thick for the height of the next three stories, and then 13 inches thick for the rest of its height.

(*s*) If the wall exceeds 45 feet in length, it shall be increased in thickness in each of the stories below the uppermost two stories by $4\frac{1}{2}$ inches, subject to the provision in this schedule respecting distribution in piers.

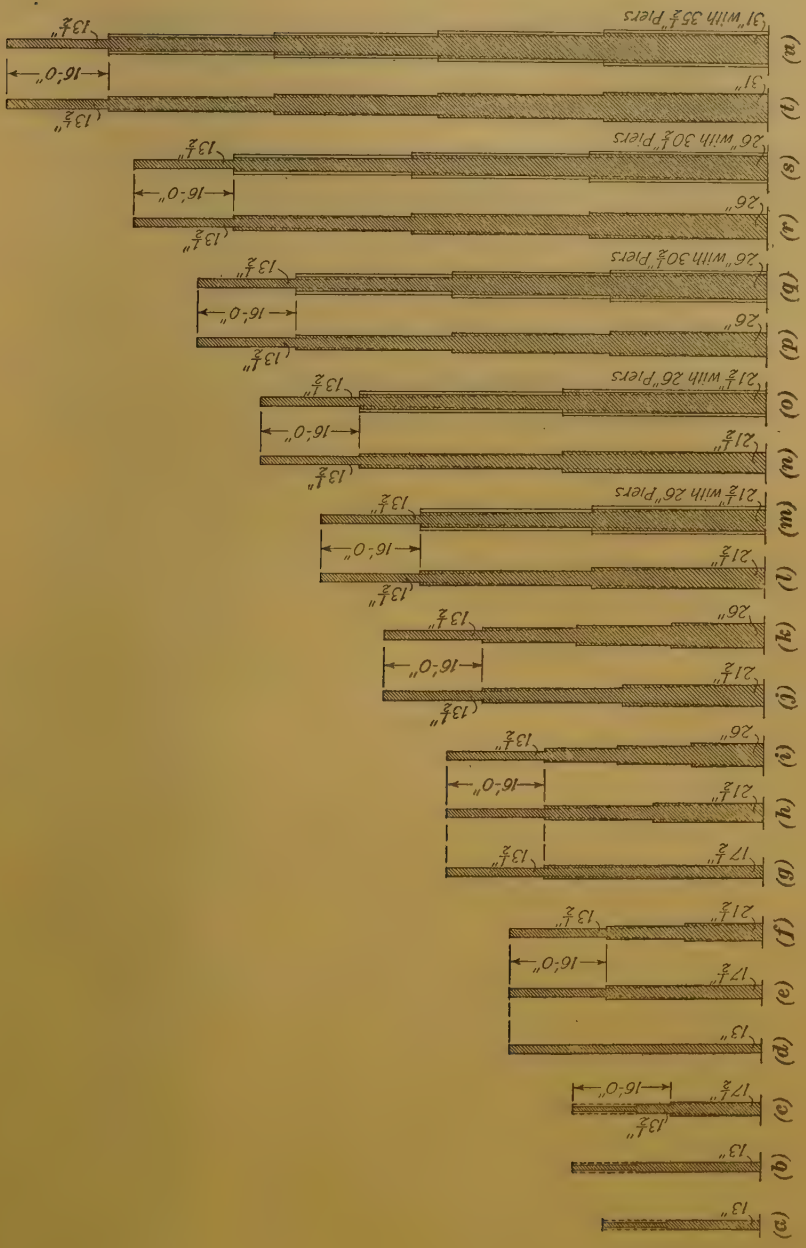
(a) 31" with 35½" Piers
31"
16'-0"
13½"
(b) 26" with 30½" Piers
26"
16'-0"
13½"
(c) 26" with 30½" Piers
26"
16'-0"
13½"
(d) 21½" with 26" Piers
21½"
16'-0"
13½"
(e) 21½" with 26" Piers
21½"
16'-0"
13½"
(f) 26"
21½"
16'-0"
13½"
(g) 26"
21½"
16'-0"
13½"
(h) 17½"
13½"
(i) 21½"
13½"
16'-0"
(k) 17½"
16'-0"
13½"
(l) 13"
(m) 13"

Fig. 6

73. Increased Thickness.—There are two requirements in the portion of the schedule referring to domestic buildings which operate in securing increased thickness of walls in certain cases. It is provided that, where a story exceeds in height 16 times the thickness prescribed in the schedule for the walls of such story, the thickness of each external and party wall throughout such story must be increased to one-sixteenth the height of the story, and that the walls below the story must be increased to a like extent. Such increased thickness may, however, be confined to piers properly distributed, of which the collective widths amount to one-fourth the length of the wall. It is further provided that no story enclosed with walls less than 13 inches thick may be more than 10 feet in height, measured between the floor and the ceiling, or between the floor and the tie of the roof.

74. Thickness of Walls of Warehouse Buildings.—The required thicknesses for external and party walls of buildings of the warehouse class are shown in Fig. 6, which has been prepared from the requirements in Part II of the schedule. It will be noted that the schedule specifies the thickness at a point 16 feet below the top and the thickness at the base, and states that the wall must not be of less thickness than would be the case if the wall were to be built solid between straight lines drawn on each side of the wall and joining the thickness at the base to the thickness 16 feet below the top. Such lines are shown dotted in Fig. 6. The changes in thickness do not necessarily occur at the floor levels. The Act is as follows, having been lettered to correspond with the thicknesses shown in the illustration :

The external and party walls of buildings of the warehouse class shall at the base be made of not less thickness than the thickness hereinafter specified in each case, viz. :

1. (*a*) Where the wall does not exceed 25 feet in height, whatever its length, it shall be 13 inches thick at its base.

2. Where the wall exceeds 25 feet, but does not exceed 30 feet in height, it shall be at its base of the thickness following :

(*b*) If the wall does not exceed 45 feet in length, it shall be 13 inches thick at its base.

(*c*) If the wall exceeds 45 feet in length, it shall be $17\frac{1}{2}$ inches thick at its base.

3. Where the wall exceeds 30 feet, but does not exceed 40 feet in height, it shall be at its base of the thickness following :

(*d*) If the wall does not exceed 35 feet in length, it shall be 13 inches thick at its base.

(*e*) If the wall exceeds 35 feet, but does not exceed 45 feet in length, it shall be $17\frac{1}{2}$ inches thick at its base.

(*f*) If the wall exceeds 45 feet in length, it shall be $21\frac{1}{2}$ inches thick at its base.

4. Where the wall exceeds 40 feet, but does not exceed 50 feet in height, it shall be at its base of the thickness following :

(*g*) If the wall does not exceed 30 feet in length, it shall be $17\frac{1}{2}$ inches thick at its base.

(*h*) If the wall exceeds 30 feet, but does not exceed 45 feet in length, it shall be $21\frac{1}{2}$ inches thick at its base.

(*i*) If the wall exceeds 45 feet in length, it shall be 26 inches thick at its base.

5. Where the wall exceeds 50 feet, but does not exceed 60 feet in height, it shall be at its base of the thickness following :

(*j*) If the wall does not exceed 45 feet in length, it shall be $21\frac{1}{2}$ inches thick at its base.

(*k*) If the wall exceeds 45 feet in length, it shall be 26 inches thick at its base.

6. Where the wall exceeds 60 feet, but does not exceed 70 feet in height, it shall be at its base of the thickness following :

(*l*) If the wall does not exceed 45 feet in length, it shall be $21\frac{1}{2}$ inches thick at its base.

(*m*) If the wall exceeds 45 feet in length, it shall be increased in thickness from the base up to within 16 feet from the top of the wall by $4\frac{1}{2}$ inches, subject to the provision in this schedule respecting distribution in piers.

7. Where the wall exceeds 70 feet, but does not exceed 80 feet in height, it shall be at its base of the thickness following :

(*n*) If the wall does not exceed 45 feet in length, it shall be $21\frac{1}{2}$ inches thick at its base.

(*o*) If the wall exceeds 45 feet in length, it shall be increased in thickness from the base up to within 16 feet from the top of the wall by $4\frac{1}{2}$ inches, subject to the provision in this schedule respecting distribution in piers.

8. Where the wall exceeds 80 feet, but does not exceed 90 feet in height, it shall be at its base of the thickness following :

(*p*) If the wall does not exceed 45 feet in length, it shall be 26 inches thick at its base.

(*q*) If the wall exceeds 45 feet in length, it shall be increased in thickness from the base up to within 16 feet from the top of the wall by $4\frac{1}{2}$ inches, subject to the provision in this schedule respecting distribution in piers.

9. Where the wall exceeds 90 feet, but does not exceed 100 feet in height, it shall be at its base of the thickness following :

(*r*) If the wall does not exceed 45 feet in length, it shall be 26 inches thick at its base.

(*s*) If the wall exceeds 45 feet in length, it shall be increased in thickness from the base up to within 16 feet from the top of the wall by $4\frac{1}{2}$ inches, subject to the provision in this schedule respecting distribution in piers.

10. Where the wall exceeds 100 feet, but does not exceed 120 feet in height, it shall be at its base of the thickness following :

(*t*) If the wall does not exceed 45 feet in length, it shall be 31 inches thick at its base.

(*u*) If the wall exceeds 45 feet in length, it shall be increased in thickness from the base up to within 16 feet from the top of the wall by $4\frac{1}{2}$ inches, subject to the provision in this schedule respecting distribution in piers.

11. The thickness of the wall at the top, and for 16 feet below the top, shall be $13\frac{1}{2}$ inches, and the intermediate parts of the wall between the base and 16 feet below the top shall not be of less thickness than would be the case if the wall were to be built solid throughout the space between straight lines, drawn on each side of the wall, and joining the thickness at the base to the thickness at 16 feet below the top.

Nevertheless, in walls not exceeding 30 feet in height, the walls of the topmost story may be 9 inches thick, provided the height of that story does not exceed 10 feet.

75. Repealed Portions of Part VI.—The sections of Part VI of the Act of 1894 which have been completely repealed are Section 63, which relates to the provision of means of escape from buildings exceeding 60 feet in height, Sections 75 and 76, which limit the cubical extent of trade buildings, and Section 77, which relates to the formation of openings in party walls. Also, that portion of Section 61 which relates to the provision of dormer windows or trap-doors to the roofs of buildings exceeding 30 feet in height has been repealed. The requirements relating to means of escape in case of fire and means of access to roofs have been re-enacted with increased stringency in the London Building Acts Amendment Act, 1905, and new requirements as to cubical extent, and the formation of openings in party walls, are contained in the London County Council (General Powers) Act, 1908.

76. Recesses and Openings.—The rules in Section 54 of the Act of 1894 which have reference to the formation of openings

and recesses in external walls and of recesses in party walls should be committed to memory ; these rules are as follows :

Recesses and openings may be made in external walls provided :

(*a*) That the backs of such recesses are not of less thickness than $8\frac{1}{2}$ inches ; and

(*b*) That the area of such recesses and openings above the ground story do not, taken together, exceed one-half of the whole area of the wall above the ground story in which they are made.

Recesses may be made in party walls provided :

(*a*) That the backs of such recesses are not of less thickness than 13 inches ; and

(*b*) That over every recess so formed an arch of at least two rings of brickwork of the full depth of the recess be turned on every story, except in the case of recesses formed for lifts, but, where such recess does not exceed 5 inches in depth, corbelling in brick or stone may be substituted for the arching ; and

(*c*) That the area of such recesses do not, taken together, exceed one-half of the whole area of the wall of the story in which they are made ; and

(*d*) That such recesses do not come within $13\frac{1}{2}$ inches of the inner face of the external walls.

An opening shall not be made in any party wall except in accordance with the provisions of this Act in relation thereto.

Provided that it shall be lawful for the superintending architect, on application made to him in accordance with any rules made in that behalf by the Council, to give consent in writing to any modification or relaxation of the requirements of this section with respect to the area of recesses and openings in any special cases where he may think proper. The word area as used in this section shall mean the area of the vertical face or elevation of the wall or recess to which it refers.

The rules given in Section 60 as to chases in party walls should be read together with those having reference to recesses in party walls. The superintending architect has power, upon application being made to him, to relax the requirements of Section 54.

77. Timber in External Walls.—The following are the requirements of Section 55 of the Act of 1894 with regard to timber in external walls :

All woodwork fixed in any external wall, except bressummers and story posts under the same, and frames of doors and windows of shops on the ground story of any building, shall be set back 4 inches at the least from the external face of such wall. But loophole frames, and frames of doors and windows, may be fixed flush with the face of any external wall :

Provided that it shall be lawful for the Council, by by-law or otherwise, to exempt from the provisions of this section oak, teak, or other wood, provided the work be constructed to the satisfaction of the district surveyor.

It should be especially noticed that the frames of doors and windows are specially exempted from the requirement as to the setting back of timber from the face of the building.

78. Construction of Bressummers.—A bressummer is defined in Section 5 of the Act of 1894 as a wooden beam or a metallic girder which carries a wall. Several requirements as to the construction of bressummers are contained in Section 56. The most important of these deals with the provision of piers at the ends of bressummers, and, in addition, the construction of intermediate supports should such be required by the district surveyor. Further requirements apply, which have reference, among other things, to the provision of a space for expansion in the case of a metallic bressummer, and to the provision of proper templates or corbels in the case of all bressummers. The rules contained in this section should be consulted whenever designs for girderwork are being prepared.

79. Heights of Parapet and Party Walls.—Section 57 of the Act of 1894 provides that if any gutter, any part of which is formed of combustible materials, adjoin an external wall, such wall must be carried up so as to form a parapet 1 foot at least above the highest part of the gutter. The thickness of such parapet wall must not be less than $8\frac{1}{2}$ inches. Section 59 deals with the carrying up of party walls above the roof. It is there provided that every party wall must be carried up above the roof, flat, or gutter of the highest building adjoining thereto to a height of at least 3 feet in the case of a building of the warehouse class exceeding 30 feet in height, and at least 15 inches in the case of any other building. The height specified is, in the case of a wall adjoining a roof, to be measured at right angles to the slope of the roof. The thickness of such carried-up wall must, in the case of a building of the warehouse class, be equal to the thickness of the wall in the topmost story, and in any other building be at least $8\frac{1}{2}$ inches. It is further provided that every party wall must be carried up of the thickness

aforesaid above any turret, dormer, lantern light, or other erection of combustible materials fixed on the roof or flat of any building within 4 feet of such party wall, and shall extend at least 12 inches higher and wider on each side than such erection. Also, every party wall is required to be carried up above any part of any roof opposite thereto and within 4 feet therefrom.

80. Illustrations of Requirements. — The requirements of Sections 57 and 59 as to the carrying up of parapet and party walls are illustrated in Figs. 7 to 9. In Fig. 7 the views (*a*) and (*b*) are, respectively, a section and elevation of a roof showing

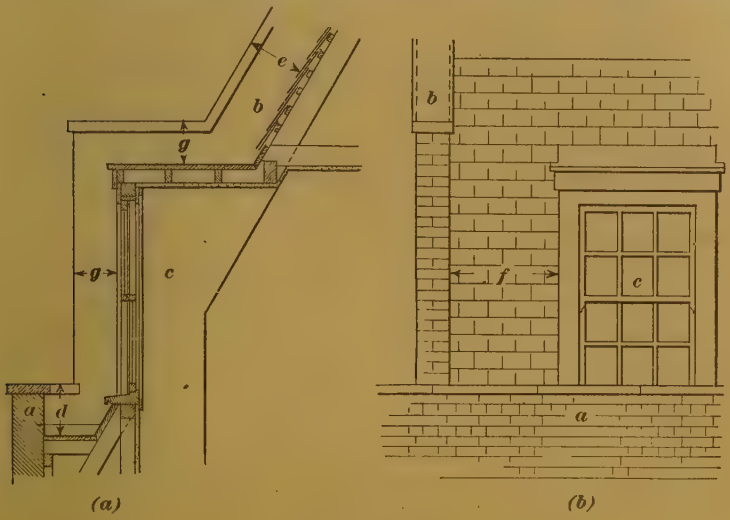

FIG. 7

a parapet *a*, a party wall *b*, and a dormer window *c*. Unless the roof is of fire-resisting construction, and consequently no part of the gutter is formed of combustible materials, the height *d* of the parapet wall must not be less than 12 inches. If the building is a domestic building, or if it is one of the warehouse class not exceeding 30 feet in height, the height *e* of the party wall above the roof, measured at right angles to the slope of the roof, must not be less than 15 inches. If the building is one of the warehouse class, and exceeds 30 feet in height, the height *e* of the party wall must not be less than 3 feet. It

is assumed that the distance *f* from the dormer *c* to the party wall *b* is less than 4 feet. Then, in order to comply with the requirements of the Act, the party wall must be constructed so as to extend 12 inches higher and wider than the dormer. The distance *g* represents the extent to which the brickwork of the party wall extends beyond the lines of the front and top of the dormer ; this distance must not be less than 12 inches.

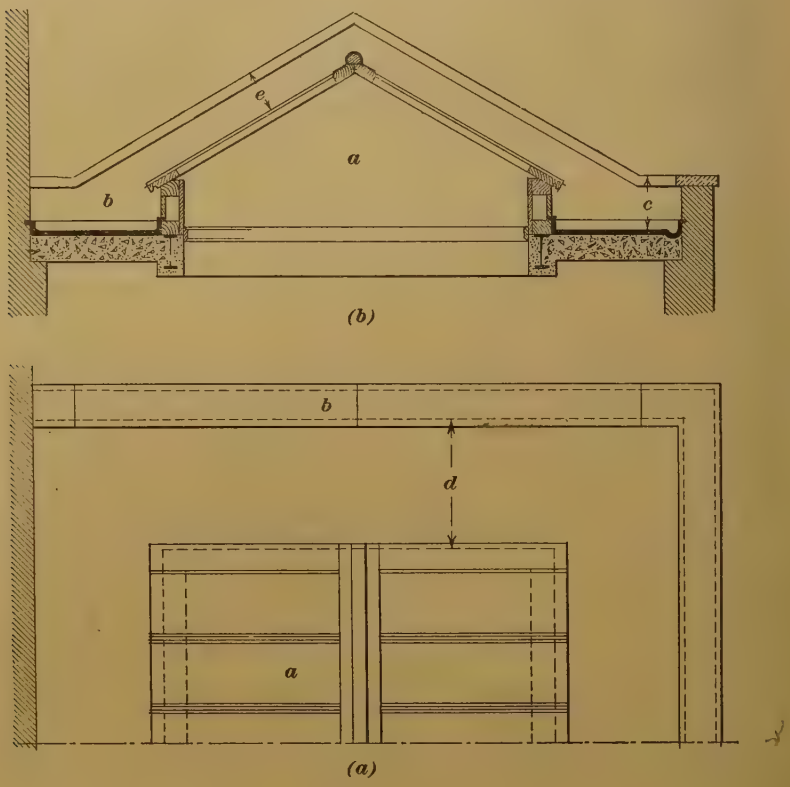

Fig. 8

81. A case of somewhat similar character is shown in Fig. 8, in which (*a*) represents a plan of a flat roof with a skylight *a* rising above the roof, and (*b*) a section through the roof at the point where the skylight occurs. It is assumed that the building is a domestic building, or, if of the warehouse class, that it does

not exceed 30 feet in height. The party wall *b* is carried up above the roof for a distance *c* of 15 inches. As the dimension *d* is considered to be less than 4 feet, the party wall is carried up so that the dimension *e* equals 12 inches.

82. In Fig. 9 is shown the application of the requirement that every party wall is to be carried up above any part of any roof opposite thereto and within 4 feet therefrom. A party wall *a* is shown with a roof sloping down to it on either side. The roof on the left-hand side has an angle of slope *b* of 30°; that on the right-hand side has an angle of slope *c* of 60°. The party wall *a* must therefore be carried up until the distance *d* equals 4 feet. It is obvious that, if the provisions of the Act are complied with as regards the steeper-pitched roof, they will be more than complied with as regards the lower-pitched roof.

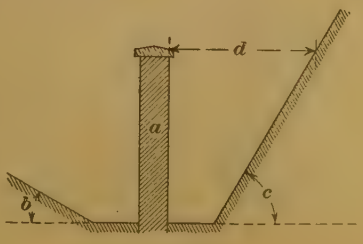

FIG. 9

83. Construction of Roofs.—The rules with regard to the construction of roofs are contained in Sections 61 and 62 of the Act of 1894. Section 61 provides that the flat gutter and roof of every building, and every turret, dormer, lantern, skylight, or other erection placed on the flat or roof of a building must be externally covered with slates, tiles, metal, or other incombustible materials. It is provided, however, that the wooden cornices and barge boards of dormers, in cases when these wooden cornices and barge boards do not exceed 12 inches in depth, and the doors, door frames, windows, and window frames of such dormers, turrets, lantern lights, and skylights are not included in this requirement. The section specifies a maximum allowable pitch for roofs, that varies according to the class of the building which it is desired to roof. The maximum allowable pitch in the case of a building of the warehouse class is 47°; that in the case of a domestic building is 75°. This requirement as to maximum pitches does not apply to towers, turrets, or spires.

Section 62 provides that not more than two stories may be constructed in the roof of a domestic building. Any story constructed in the roof of a domestic building, at such a height that the upper surface of the floor of the story is more than 60 feet above the street level, must be constructed of fire-resisting materials.

In every case where the term *fire-resisting material* is used in the Building Acts, the term must be read as meaning one of the materials comprised in the schedule of fire-resisting materials given in the London Building Acts Amendment Act, 1905.

84. Construction of Chimneys and Flues.—The regulations with regard to the construction of chimneys and flues are contained in Sections 64 to 66 of the Act of 1894. The requirements are given in full detail, and as they are reasonably clear and intelligible, they are not quoted here. Reference, as regards these requirements, must be made to the Act itself. The provisions of Section 64 are the most important, for these deal, among other things, with the detailed construction of fireplace openings, hearths, and flues of the kind required in the erection of an ordinary building. The size of flues is not regulated by the Act; in practice, in London, flues are almost invariably made 9 inches by 9 inches in area. But very many important details of construction are regulated by Section 64. The thickness of the jambs of fireplace openings may in no case be less than $8\frac{1}{2}$ inches. The thickness of the brickwork surrounding smoke flues must be at least 4 inches. The thickness of the backs of fireplace openings in party walls must be $8\frac{1}{2}$ inches up to a height of 12 inches above the mantel, at which point it may be reduced to 4 inches.

The construction, width, and thickness of hearths are regulated by Subsections 15 to 17. Hearths are required to be at least 6 inches longer on either side than the width of the fireplace opening for which they are provided, and to be at least 18 inches wide in the other direction, measured from the face of the chimney breast. On the lowest floor, a hearth may be bedded direct on concrete; on all other floors it must be laid on stone or iron bearers, or on brick trimmer-arches or other incombustible materials.

85. A considerable number of other important constructional requirements will be found in Section 64. These should be carefully studied, and, as far as possible, committed to memory. Sections 65 and 66 deal with matters of construction of a less ordinary character, and will not often be required to be consulted. Section 67, which deals with the construction of a floor over an oven or over an enclosed space in which a furnace is fixed, is of comparatively rare application.

86. Construction of Habitable Rooms. — The provisions of Section 69 of the Act of 1894 which have reference to the ventilation of staircases need not receive much attention No competent architect would plan his building so badly as to have an unventilated staircase. The requirements of Section 70 should be noted, although, here again, even should such requirements not exist, few architects would think of designing a building in such a manner as to provide a smaller height of rooms or less area of window space than those specified in the section. It is provided that every habitable room, other than rooms wholly or partly in the roof, must be at least 8 feet 6 inches in height from floor to ceiling. Every habitable room wholly or partly in the roof must be at least 8 feet in height from floor to ceiling throughout not less than half the area of the room. The requirements as to the window space to be provided are as follows:

Every habitable room shall have one or more windows opening directly into the external air, or into a conservatory, with a total superficies clear of the sash frames, free from any obstruction to the light, equal to at least one-tenth of the floor area of the room, and so constructed that a portion equal to at least one-twentieth of such floor area can be opened and the opening in each case shall extend to at least 7 feet above the floor level; but a room having no external wall, or a room constructed wholly or partially in the roof, may be lighted through the roof by a dormer window with a total superficies clear of the sash frames, free from any obstruction to the light, equal to at least one-twelfth of the floor area of the room, and so constructed that a portion of such window equal to at least one twenty-fourth of such floor area can be opened and the opening in each case shall extend to at least 5 feet above the floor level; or such room may be lighted by a lantern light of which a portion equal to at least one-twentieth of the floor area can be opened.

87. It will be seen that two cases are considered; the first that of an ordinary room and the second that of a room which has no external wall or which is constructed wholly or partly in the roof, the requirements as to window space varying from one-tenth in the first case to one-twelfth in the second case if the light is provided by a dormer window, or to an unspecified area, of which a portion equal to one-twentieth of the floor area must open, when the light is provided by a lantern light.

The section also deals with the ventilation of basement floors, when formed of timber and not constructed as solid floors, and regulates the construction of the floors of and the approaches to habitable rooms constructed over stables.

SPECIAL FORMS OF CONSTRUCTION

88. **Accesses and Stairs in Certain Buildings.**—Sections 68 and 80 of the Act of 1894, which deal principally with the provision and construction of stairs in certain buildings, may conveniently be dealt with together. Section 68 provides that, in every public building, and in every building having a greater cubical extent than 125,000 cubic feet, and which is constructed or adapted to be used as a dwelling house for separate families, the floors of the lobbies, corridors, passages, and landings, and also the flights of stairs must be of fire-resisting material, carried on supports of fire-resisting material. Section 80 deals with the provision of staircases in certain specified types of public buildings. The requirements of this section are quoted in full:

The following rules shall be observed with respect to new churches, chapels, meeting houses, public halls, public lecture rooms, public exhibition rooms, and public places of assembly, or additions or alterations by which increased accommodation is to be provided to existing churches, chapels, meeting houses, public halls, public lecture rooms, public exhibition rooms, or public places of assembly:

(*a*) Every staircase for the use of the public shall be supported and enclosed by brick walls not less than 9 inches thick. The treads of each flight of stairs shall be of uniform width.

(*b*) No staircase, internal corridor, or passageway, for the use of the public shall be less than 4 feet 6 inches wide. Provided that, where not more than 200 persons are to be accommodated in such church, chapel,

meeting house, hall, lecture room, exhibition room, or place of assembly, such staircase, internal corridor, or passageway, may be of the width of 3 feet 6 inches.

(*c*) Every staircase, corridor, or passageway, for the use of the public, and which communicates with any portion of the building intended for the accommodation of a larger number of the public than 400, shall be increased in width by 6 inches for every additional 100 persons until a maximum width of 9 feet be obtained. Provided always that, in every case where the staircases are 6 feet wide and upwards, they shall be divided by a hand rail. Provided also that, in lieu of a single staircase, corridor, or passageway of the width in this subsection prescribed, it shall be lawful to substitute two staircases, corridors, or passageways, each being of a width at least equal to two-thirds of the width in this subsection prescribed for the single staircase, corridor, or passageway, but so that neither of such two substituted corridors, staircases, or passageways shall be less than 3 feet 6 inches wide.

(*d*) In all cases where a portion of the public is to be accommodated over or at a higher level than others of the public, a separate means of exit of the width above prescribed for staircases, internal corridors, or passageways, and communicating directly with the street or open space, shall be provided from each floor or level.

(*e*) All doors and barriers shall be made to open outwards, and no outside locks or bolts are to be affixed thereto.

Special attention should be devoted to that requirement which necessitates the provision of a separate means of exit from each different level, for this will very materially affect the planning of a building coming within the scope of this section.

89. Arches Over or Under Public Ways.—Sections 71 and 72 of the Act of 1894 deal with the construction of arches and floors over or under public ways or passages leading to premises in other occupation. The requirements throughout are of a constructional character, designed for the purpose of securing sufficient strength to resist the loads imposed. A comparison of the provisions of the two sections will show that much greater strength is required in the case of an arch, or other construction under a passage or public way, than when the arch supports a portion of a building which extends over the passage. In either case, it is possible to adopt a different form of construction from that specified in the sections, provided that incombustible material is used and the construction is approved by the district surveyor.

90. Projections.—Section 73 of the Act of 1894, which deals with the subject of projections, demands special attention. Its provisions are not solely constructional, but also have reference to the distances to which certain projections may extend either in advance of the general line of buildings in the street, or in advance of the main front of the building of which they form part. It is possible to apply to the Council for consent to the relaxation or modification of any requirement contained in this section. The section is divided into eight subsections. Subsection 1 provides that a large number of specified projections must be of brick, tile, stone, artificial stone, slate, cement, or other fireproof material. There is no definition in the Act of the term *fireproof*, but it is generally considered that the use of materials which are specified as fire-resisting will constitute a substantial compliance with the section. Subsection 2 requires that every balcony, cornice, or other projection shall be tailed into the wall of the building and weighted or tied down to the satisfaction of the district surveyor; the projection of a cornice over the public way must not exceed 2 feet 6 inches without the consent of the Council. Subsection 3 allows shop fronts to project slightly in advance of the external wall of the building to which they belong. The extent of the projection allowed varies in accordance with whether or not the width of the street or way on which the shop abuts exceeds 30 feet. Where this width is less than 30 feet, the maximum allowable projection of the shop front is 5 inches, and of the cornice, 13 inches. Where the width of the street exceeds 30 feet, the maximum allowable projection is, in the case of the shop front, 10 inches, and in the case of the cornice, 18 inches. No part of a shop front, with the exception of the cornice, is allowed to project over the public way. Subsection 4 deals with the construction of shop fronts. The use of woodwork is prohibited above a level of 25 feet from the footway, and except under certain specified conditions no woodwork of a shop front may be placed nearer than 4 inches to the centre of a party wall.

91. Subsections 5 and 6 of Section 73 contain special provisions allowing the construction, subject to compliance with

certain specified rules, of windows to dwelling houses and of projecting oriel windows or turrets, in connection with buildings the front walls of which are not less than 40 feet from the opposite side of the street. These provisions override the requirements of Section 22 as to the illegality of the erection of structures in advance of the general line of buildings without the consent of the Council. The rules admitting of the erection of bay windows to dwelling houses having front walls not less than 40 feet from the opposite side of the street are that such bay windows:

(*a*) Do not exceed three stories in height above the level of the footway;

(*b*) Do not project more than 3 feet from the main wall of the building to which they are attached;

(*c*) Do not project in any part within the prescribed distance of the centre of the roadway;

(*d*) Are in no part nearer to the centre of the nearest party wall than the extreme amount of their projection from the main wall of the building to which they are attached;

(*e*) Do not, taken together, exceed in width three-fifths of the frontage of the building toward the street to which such bays face;

(*f*) Are not constructed upon any part of the public way or upon any land agreed to be given up to the public way; and

(*g*) Shall not be used for trade purposes.

Unless bay windows comply with the foregoing rules, they may not be erected in advance of the general line of buildings without the consent of the Council.

92. The construction of oriel windows and turrets to buildings having front walls not less than 40 feet from the opposite side of the street is allowed, provided that:

(*a*) No part of any such projection extend more than 3 feet from the face of the front wall of the building or more than 12 inches over the public way;

(*b*) No part of any such projection be less than 10 feet above the level of the footway of the street;

(*c*) No part of any such projection, where it overhangs the public way, be within a distance of 4 feet of the centre of the nearest party wall;

(*d*) On no floor shall the total width of any such projections, taken together, exceed three-fifths of the length of the wall of the building on the level of that floor;

(*e*) Every such projection be constructed to the satisfaction of the district surveyor, or, in the event of disagreement, to the satisfaction of the superintending architect, whose determination shall be final.

Unless oriel windows or turrets comply with the foregoing rules, they may not be erected without the consent of the Council.

93. Subsection 7 of Section 73 requires the provision of gutters and rain-water pipes to roofs, flats, balconies, verandas, shop fronts, and projecting windows, so that water may be prevented from dropping on or running over the public way. Subsection 8 contains a general prohibition of the erection of projections in advance of the general line of buildings without the consent of the Council. Water pipes, copings, string-courses, fascias, window dressings, and other similar architectural decorations are, however, allowed to project.

CONSTRUCTION OF CERTAIN EXCEPTIONAL BUILDINGS

94. Separation and Subdivision of Buildings.—Section 74 of the Act of 1894 deals with the separation of buildings from one another, the subdivision of every building of a certain area used partly as a dwelling house and partly for purposes of trade or manufacture, and the construction of every building of a certain area which it is proposed to be let in several occupations. The section provides, in the first instance, that every building shall be separated, either by external walls or by party walls or other proper party structures, from adjoining buildings. The requirements of the rest of the section are as follows :

In every building exceeding 10 squares in area, used in part for purposes of trade or manufacture and in part as a dwelling house, the part used for the purposes of trade or manufacture shall be separated from the part used as a dwelling house by walls and floors constructed of fire-resisting materials, and all passages, staircases, and other means of approach to the part used as a dwelling house shall be constructed throughout of fire-resisting materials. The part used for purposes of trade or manufacture shall, if extending to more than 250,000 cubic feet, be subject to the provisions of this Act relating to the cubical extent of buildings of the warehouse class :

Provided that there may be constructed in the walls of such staircases and passages such doorways as are necessary for communicating between

the different parts of the building, and there may be formed in any walls of such building openings fitted with fire-resisting doors.

In every building exceeding 25 squares in area containing separate sets of chambers, or offices, or rooms, tenanted or constructed or adapted to be tenanted by different persons, the floors and principal staircases shall be of fire-resisting materials:

But this provision shall not entitle the district surveyor to charge for the inspection of each set of chambers as a separate building.

95. Public Buildings.—There is no schedule governing the thickness of the walls of public buildings, also none of the general provisions of Part VI apply to public buildings. Such buildings are, as regards their construction, regulated by no hard and fast rules, but must be constructed in every important detail in accordance with the requirements of the district surveyor, or, in any case of disagreement, with those of the Tribunal of Appeal. This is set forth very clearly in Section 78 of the Act of 1894, which is as follows:

Notwithstanding anything in this Act, every public building, including the walls, roofs, floors, galleries, and staircases, and every structure and work constructed or done in connection with or for the purposes of the same, shall be constructed in such manner as may be approved by the district surveyor, or, in the event of disagreement, may be determined by the Tribunal of Appeal; and, save so far as respects the rules of construction, every public building shall throughout this Act be deemed to be included in the term building, and be subject to all the provisions of this Act in the same manner as if it were a building erected for a purpose other than a public purpose.

No public building shall be used as such until the district surveyor or the Tribunal of Appeal shall have declared his or their approval of the construction thereof.

After the district surveyor shall have so declared his approval or shall certify that it has been constructed as directed by the Tribunal of Appeal, any work affecting or likely to affect the building shall not be done to in or on the building without the approval of the district surveyor or such certificate as aforesaid.

Section 79 prohibits the conversion of any building into a public building unless the construction of such building is made to conform to the requirements of the district surveyor, or, in case of dispute, to those of the Tribunal of Appeal. The necessary compliance with the provisions of this section may, in certain cases, involve great structural alterations.

CONSTRUCTION OF SPECIAL AND TEMPORARY BUILDINGS

96. Special Buildings and Structures.—Section 82 is the first of the five sections forming Part VII of the Act of 1894. This section provides that when a person is desirous of erecting an iron building or structure or any other building or structure to which the general provisions of Part VI of the Act are inapplicable, or, in the opinion of the Council, inappropriate, having regard to the special purpose for which the building or structure is designed, he must apply to the Council for consent. In making his application, he must forward a plan of the building or structure, together with such particulars relating to the proposed construction as may be required by the Council. It is sometimes not very easy to determine whether a certain building or structure is one to which the provisions of this section apply, or whether it must be erected in conformity with the rules contained in Part VI. It is a general practice in such cases to obtain the opinion of the district surveyor.

97. Temporary Buildings and Structures.—Section 83 of the Act of 1894 deals with the erection of buildings or structures of a temporary character to which the general provisions of Part VI are inapplicable. The Council under this section may consent to the erection of buildings or structures of this kind, and to their retention for a fixed period of time. On the expiration of the period allowed for the retention of any building or structure, the Council have power to require the removal of such building or structure, but in most cases the Council will be willing to consider an application for the extension of the period originally allowed. The provisions of the section do not admit of the erection of all kinds of buildings as temporary buildings, but only buildings to which the general provisions of Part VI are inapplicable. In the event of the Council being asked to give their consent to the construction in a temporary manner of a building of an ordinary character, the person applying would probably be told that he must construct the building in accordance with the ordinary requirements of Part VI. Buildings and structures which come within the scope of

Section 83 are those which are erected for temporary use, and on which account are not required to be constructed in such a permanent and expensive manner as ordinary buildings.

98. Wooden Structures.—Section 84 provides that no person shall erect a wooden structure, except hoardings enclosing vacant land, and not exceeding 12 feet in height, without having first obtained a licence from the Council. The Council, however, are not now the licensing authority as regards wooden structures, for the powers of the Council under this section were transferred to the borough councils by the London Government Act, 1899. Thus, an application for a licence to erect a wooden structure must always be made to the local borough council. It is provided in Section 84 that a licence shall not be required in respect of a wooden structure of a movable or temporary character erected by a builder for his use during the carrying out of building works, and that the requirements in the section are not to apply within the City, or to a hoarding licensed by a borough council. Many borough councils consent to the erection of small wooden buildings under this section, and the Council also consent to the erection of buildings of this character under Section 83, so that there may be some difficulty in deciding whether to approach the Council or the borough council in respect of a licence for a wooden building.

LAW AS TO PARTY STRUCTURES

RIGHTS OF BUILDING AND ADJOINING OWNERS

99. Special State of Affairs in Metropolis.—The whole of Part VIII of the Act of 1894 deals with the rights of building and adjoining owners with regard to party walls and other party structures. Statutory provisions of this nature are peculiar to the Metropolis. Rights as to party walls and other party structures in districts outside London are regulated by the *common law*, or law which is based on custom affirmed from time to time by legal decisions, but which is not embodied in any written

statutes or codes. Owners of buildings in London, therefore, have their legal position with regard to party structures much more clearly defined than owners of buildings in the provinces. Part VIII of the Act not only specifies the rights of owners with regard to party structures, but also prescribes, in detail, the procedure which must be adopted if such rights are to be legally exercised.

100. Erection of Party Wall. — Section 87 provides that where lands of different owners adjoin, and are unbuilt on at the line of junction, and either owner is about to build on any part of the line of junction, such owner must serve on the adjoining owner a notice describing the intended wall. Then, if the adjoining owner consents to the building of a party wall, the wall may be built as such. The expense of building a party wall must be defrayed from time to time by the two owners in due proportion according to the respective use made by the two owners; that is, if only one owner at first uses the wall, he, for the time being, must pay the full cost. Then, later on, if the owner on the other side erects a building, he will be obliged to pay his share of the cost of the wall according to the extent to which it is used by him, this depending, of course, on the height of his building. If he erects a building extending to the same height as the adjoining building, he must pay the owner who was the first to build half the amount expended in erecting the party wall.

101. Erection of External Wall.—If the adjoining owner, after having received a notice from the building owner as to the proposed erection of a party wall, objects to the building of such wall, the building owner must erect an external wall, placed wholly on his own land. If the building owner in the first instance desires to erect an external and not a party wall, he may serve a notice on the adjoining owner describing the proposed wall. In such case, and also in the case where he is required to build an external wall instead of a proposed party wall, he may, after the expiration of 1 month from the service of the notice, project the footings and foundation on one side of his wall into the land of the adjoining owner. Compensation

in such case is to be made to the adjoining owner or occupier for any damage which he may sustain. Where an external wall is built against an existing wall the section provides that the district surveyor may allow the footings of the new wall on this side to be omitted.

102. Rights of Building Owner.—Section 88 of the Act of 1894 specifies a list of rights which may be exercised by the building owner. This section should be carefully read by every person about to prepare working drawings for a building in London who is not well acquainted with the rights that may be exercised by a building owner. As the architect acts on behalf of the building owner, the rights specified in the section are, in effect, the rights of the architect. The majority of the twelve subsections of this section confer on the building owner the right to make good or pull down party structures of various characters which are either defective or are not in accordance with the provisions of the Act. Subsections 6 and 12, however, deal with matters unconnected with defective or irregular structures. Subsection 6 provides that a building owner has a right to raise and underpin any party structure permitted by the Act to be raised or underpinned, or to raise or underpin any external wall built against a party structure, on the condition that he makes good all damage to the structure or decorations of the adjoining premises, and carries up to the requisite height all flues and chimney stacks belonging to the adjoining owner which occur on or against the party structure or external wall which is raised. Subsection 12 gives the building owner a right to raise a party fence wall, or to pull down such a wall and rebuild it as a party wall.

103. Rights of Adjoining Owner.—Section 89 of the Act of 1894 deals with the rights of an adjoining owner. It provides that, where a building owner proposes to exercise any of his rights with respect to party structures, the adjoining owner may by notice require the building owner to build, in connection with the party structure under consideration, such chimney copings, jambs, breasts, or flues, or such piers or recesses, or any such other like works as may be fairly required for the

convenience of the adjoining owner. The building owner must comply with such a requisition in all cases where the execution of the works will not be injurious to him or cause him unnecessary inconvenience or delay.

104. Exercise of Rights by Owners.—Section 90 provides that, except with the consent in writing of the adjoining owner and of the adjoining occupiers, or in a case where a wall or party structure is dangerous, a building owner shall not exercise any of his rights in respect of a party fence wall, unless at least 1 month, or exercise any of his rights in respect of a party structure other than a party fence wall unless at least 2 months, before doing so he has served on the adjoining owner a proper notice describing the nature and particulars of the intended work and the time at which it is proposed to be commenced. When a building owner, in the exercise of any of his rights, lays open any part of the adjoining land or building, he must make and maintain proper hoarding and shoring or temporary construction for the protection of the adjoining land or building and the security of the adjoining occupier. A building owner must not exercise any right in such a manner as to cause unnecessary inconvenience to the adjoining owner or occupier. Any right able to be exercised under a notice will lapse if the work to which the notice refers is not begun within 6 months of the service of the notice.

105. An adjoining owner, after having received a notice from a building owner, may, within 1 month after the receipt of the notice, serve on the building owner a notice requiring him to build, on the party structure to which the notice refers, any works which he, the adjoining owner, is entitled to demand. Such works are set forth in Section 89. This last-mentioned notice must specify the works required by the adjoining owner and must, if necessary, be accompanied by explanatory drawings. If either owner, after having received a notice of any kind under Part VIII of the Act, does not express his consent thereto within 14 days of the service of the notice, he will be considered to have dissented, and a dispute will be deemed to have arisen between the two owners.

106. Settlement of Disputes.—The methods to be adopted in the settlement of a dispute, or, as the Act terms it, a *difference* between owners, are specified in detail in Section 91. These methods consist, in the first place, in the appointment of a surveyor or surveyors to adjudicate on the matters in dispute. If both parties agree as to the appointment of a single surveyor, he will have full power to deal with the matters in dispute; but this course is rarely adopted. The second method given by the Act is generally put in force; this consists in the appointment of a surveyor by the building owner and another surveyor by the adjoining owner. These two surveyors, before dealing with the questions in dispute, must select a third surveyor. Then, if the two surveyors cannot agree as to a settlement, the third surveyor is called in to determine any points of difference. Any two of the three surveyors appointed are able, by their award, to determine all matters in dispute, including the costs incurred in making the award.

107. An award made by a surveyor or surveyors appointed by the parties to a dispute is conclusive unless, within 14 days from the date of the delivery of the written award to the parties, an appeal to the county court is made by either party. On an appeal being made, the county court may rescind the award or modify it in such manner as it thinks just. If, however, the person who makes the appeal, on appearing before the county court, declares his unwillingness to have the matter decided by that court, and proves that if the case is decided against him he will be liable to pay a sum, exclusive of costs, exceeding £50, he may, if he gives approved security, be allowed to bring an action in the High Court against the other party to the dispute. Should the parties to such action agree as to the facts, a special case may be stated for the opinion of the High Court, or, in other words, this Court will have a statement of the facts made to them, and in deciding the case will deal solely with the legal aspect.

108. The remainder of Section 91 deals with the procedure to be observed when one of the parties neglects to appoint a surveyor, or when any one of the surveyors appointed refuses

to act, or becomes incapable to act, or dies before the difference is settled. Although the term surveyor is used throughout Part VIII of the Act, it is a general custom for men practising both as architects and surveyors to be chosen to decide questions in dispute. Where an architect is erecting a building and a dispute arises as to a party structure, it is almost an invariable practice for such architect to be appointed by the building owner as his surveyor under the Act.

109. Right of Entry.—Under the provisions of Section 92 of the Act of 1894, a building owner, and his servants, agents, and workmen, at all usual hours of working, may enter and remain on any premises in order to execute any work which such owner has become entitled or is required by the adjoining owner to execute. It is provided, however, that before entering on any premises, the building owner must, except in the case of emergency, give 14 days' notice of his intention to the owner and occupier.

110. Underpinning Adjoining Building. — Where a building owner intends to erect, within 10 feet of a building belonging to an adjoining owner, a building or structure any part of which, within such 10 feet, extends to a lower level than the foundations of the adjoining building, the building owner may, and if required by the adjoining owner must, underpin or otherwise strengthen the foundations of the adjoining building so far as may be necessary. Where a building is erected in such proximity to, and at such a depth below the foundations of, an adjoining building, the building owner is required, by Section 93 of the Act of 1894, to give 2 months' notice to the adjoining owner, stating whether or not he proposes to underpin or otherwise strengthen the foundations of the adjoining building. Such notice is to be accompanied by a plan and sections showing the site of the proposed building and the depth to which it is proposed to excavate. The adjoining owner, may, within 14 days of the receipt of the notice from the building owner, serve this owner with a counter-notice either disputing the necessity of or requiring such underpinning or strengthening. A difference will then be deemed to have arisen between the two owners, which

difference must be settled by a surveyor or surveyors. A building owner is in all cases liable to compensate the adjoining owner and occupier for any loss or damage which they may incur in consequence of the exercise of any powers under this section.

111. Giving of Security.—Section 94 provides that an adjoining owner may, by notice in writing, require the building owner, before commencing any work which he may be authorized to execute by Part VIII of the Act of 1894, to give security for the payment of all such expenses, costs, and compensation as may be payable by him in respect of the work. In a similar manner, the building owner, when required by notice from the adjoining owner to execute works to a party structure, may serve on the adjoining owner a counter-requisition, requiring him to give security for payment of the expenses, costs, and compensation for which he will be liable. If within 1 month after the service of the counter-requisition the adjoining owner does not give such security, the building owner need not carry out the works required by the adjoining owner. In any case where there is a dispute as to the security to be given, this is to be decided by the judge of the county court.

112. Rules as to Expenses.—The remaining provisions of Part VIII of the Act of 1894, with the exception of Section 101, which deals with easements in party walls, relate to the payment of expenses incurred in the carrying out of works to party structures. Section 95 contains a list of cases in which expenses are incurred, and states whether in each particular instance they are to be paid entirely by the building owner, or whether they are to be borne by the building owner and the adjoining owner in due regard to the use which each owner makes of the party structure concerned. In any case where a doubt arises as to the liability for expenses, this section should be carefully consulted. Generally speaking, it may be said that, where a defective structure of any kind is repaired or rebuilt, and where works are executed in compliance with a requirement made by the adjoining owner, the expenses are to be apportioned between the owners ; in other cases they are to be borne entirely by the building owner.

Form A.—PARTY STRUCTURES.

The London Building Act 1894.

57 & 58 Victoria, c. ccxiii, Part viii, Sections 88 to 92 inclusive.

To Henry Robinson Esq.
of 105 Upper George Street Westminster. W.
As Building Owner of the Premises known as 107 Upper George Street, Westminster W.

and with reference to the Party structure
separating the said Premises from the adjoining Premises on the North side thereof known as 105 Upper George Street, Westminster, W.

I hereby give you notice that after the expiration of two months from the date of service hereof I intend to exercise the rights given to me by the London Building Act 1894. Section 88 Subsections 1 to 12 by executing the works undermentioned, viz.:—

To make good underpin and repair the party structure if defective or out of repair, or to pull down and rebuild the party structure if so far defective or out of repair as to make such operation necessary or desirable. To raise the party structure. To cut into the party structure for the purpose of building in floor joists and roof timbers. To cut away or take down such parts of the wall or building as may be necessary in consequence of such wall or building overhanging the ground of the Building Owner in order to erect an upright wall against the same And to perform any other necessary works incident to any of the above-mentioned works.

and I propose to commence the work on or about the 9th day of May 1910.

I hereby appoint
Mr. Walter Smith
of 30 Grays Inn Square - London W.C.
to act as my Surveyor.

(Signature) Wm. Jones. Building Owner.
(Address) 107 Upper George Street Westminster W.
Dated this 9th day of March 1910.

If the adjoining Owner do not within 14 days after the service of this notice express his consent thereto, he will be considered to have dissented therefrom (see Section 90), and in such case the Act requires him to appoint a Surveyor - Section 91 (1).

Fig. 10

113. Sections 96 to 100 of the Act of 1894 deal with the procedure to be observed where the building owner requires the adjoining owner to pay the share of expenses to which he is considered liable. It is provided that within 1 month after the completion of any work to a party structure and of which some of the expense is to be borne by the adjoining owner, the building owner must forward the adjoining owner an account of the expenses to which he is considered liable. At any time after the receipt of the account the adjoining owner, if dissatisfied with it, may declare his dissatisfaction to the building owner in writing, at the same time specifying his objection to the account. A difference shall then be deemed to have arisen between the two owners, which difference must be determined by a surveyor or surveyors in the manner provided for by the Act. If, however, the adjoining owner does not declare his dissatisfaction with the account within 1 month after its receipt, he will be deemed to have accepted it, and if he does not pay the amount stated in the account, it may be recovered as a debt.

114. **Notice Forms.**—The Royal Institute of British Architects have prepared forms for use under Part VIII of the Act. These forms are the copyright of the Royal Institute, but, by special permission, are shown in Figs. 10 to 14 filled in after the manner customary in practice. The extracts from and summaries of certain provisions of the Act which are printed on the forms are not, however, reproduced. The forms are lettered *A*, *B*, *C*, *D*, and *E*. Form *A*, Fig. 10, is used when it is desired to carry out works to an existing party structure; Form *B*, Fig. 11, when it is proposed to build within 10 feet of and at a lower level than the adjoining owner's building; Form *C*, Fig. 12, when an external wall is to be erected with footings projecting into the adjoining owner's premises; Form *D*, Fig. 13, when a party wall is to be built on the line of junction of adjoining lands. Form *E*, Fig. 14, deals with the appointment of a third surveyor by the two surveyors already appointed by the building owner and the adjoining owner. It should be noted that a third surveyor must always be appointed before the two surveyors commence their duties.

Form B.—INTENTION TO BUILD WITHIN TEN FEET OF, AND AT A LOWER LEVEL THAN, ADJOINING OWNER'S BUILDING.

The London Building Act 1894.

57 & 58 Victoria, c. ccxiii., Part viii., section 93.

To John Jones Esq.
of 96 Langham Place. London. W.

As Building Owner of the Premises known as 94 Langham Place. London. W.

We hereby give you notice that after the expiration of two months from the date of the service hereof we intend to erect within ten feet of the building belonging to you on the North ——— side of our own premises, and situate and being No. 96 Langham Place. London W. ———

a building or structure some part of which within the said ten feet and as shown on the plans and sections annexed hereto will extend to a lower level than the foundations of your building, and to exercise the rights given to us by the London Building Act 1894, by executing the works undermentioned, viz.:—

To underpin and repair as necessary the Party Structure or to pull down and rebuild the party structure if so far defective or out of repair as to make such operation necessary or desirable. To perform any other necessary works incident to the connection of a party structure with the premises adjoining thereto and to perform any other necessary works incident to any of the above mentioned works. ———

and we propose to commence the work on or about the 9th day of April 1910.

We hereby appoint
Mr. Smith Thompson. A.R.I.B.A.
of 96 Upper Grays Inn Road. London. W.
to act as our Surveyor.

(Signature) Bertram & Thomas Building Owner.
(Address) 72 Page Street. Soho. London. W.

Dated this 9th day of February 1910.

If the adjoining Owner shall within fourteen days after being served with the above notice give a counter notice in writing that he disputes the necessity of or requires such underpinning or strengthening, a difference shall be deemed to have arisen—Section 90 (2)—and in such case the Act requires him to appoint a Surveyor—Section 91 (1).

Fig. 11

Form C.—EXTERNAL WALLS WITH FOOTINGS PROJECTING INTO ADJOINING OWNERS' PREMISES.

The London Building Act 1894.

57 & 58 Victoria, c. ccxiii., Part viii., section 87 (5 and 6).

To James Thompson Esq.
of 81 Upper Berkeley Street London. W.

As Building Owner – of the Premises known as 26 Fairfax Gardens Kensington. W.

I hereby give you notice that after the expiration of one month from the date of service hereof I intend to erect an external wall on my own land adjoining your land situate and being between Nos. 26 and 30 Fairfax Gardens, Kensington W

on the South side of the said external wall, and to exercise the right given to me by the London Building Act 1894, by erecting a wall of the following description :—

To be built in good hard stock bricks in lime mortar five stories in height and 52 feet long. Its thickness in the lowest story will be 1'. 10½", in the first story 18", and 13½" for the remainder of its height; all as shown upon the plan attached hereto.

and by placing the projecting footings and foundations of said external wall on your land.

I hereby appoint
Mr. Hugh Green F.R.I.B.A.
of 29 Lawrence Pountney Hill London E.C.
to act as my Surveyor.

(Signature) Edmund Brayton Building Owner
(Address) 27 St George's Terrace. Hampstead. N.W

Dated this 9th day of March 1910.

Fig. 12

Form D.—PARTY WALLS ON LINE OF JUNCTION OF ADJOINING LANDS.

The London Building Act 1894.

57 & 58 Victoria, c. ccxiii., Part viii., section 87 (1, 2, 3, and 4).

To Herbert Blackburn Esqr:

of 9 Partington Gardens, Clapham S.W.

As Building Owner of the Premises known as 29 Little Portland Street, Borough, S.E.

We hereby give you notice that we desire to build a party wall partly on our own land adjoining your vacant land situate and being next to No. 33 Little Portland Street, Borough, S.E.

and to the west of our own said land.

The said party wall is desired to be of the following description:—

To be built in good hard Fletton bricks in lime mortar and of the form and dimensions shown upon the plan attached hereto

We shall be obliged by your consent and by your furnishing us with the name of your Surveyor.

We hereby appoint

Mr. G. F. Graves

of 172 Baker Street W.

to act as our Surveyor.

(*Signature*) Drayton C. Thomas. *Building Owner.*

(*Address*) 79 Finsbury Circus London E.C.

Dated *this* 15th *day of* February 1910.

Fig. 13

Form E.—APPOINTMENT OF THIRD SURVEYOR.

The London Building Act 1894.

57 & 58 Victoria, c. ccxiii., Part VIII., section 91.

We, the undersigned Surveyors, duly appointed to act respectively on behalf of

Mr. William Jones

of 107 Upper George Street, Westminster W

the Building Owner of Premises known as 107 Upper George Street, Westminster, W.

and for Mr. Henry Robinson

of 105 Upper George Street, Westminster W

the adjoining Owner of Premises known as 107 Upper George Street, Westminster, W.

both of the said premises being referred to in the notice served by the said Building Owner on the said adjoining Owner on the 9th day of March 1910 hereby select

Mr. Thomas Redfern

of 197 Victoria Street, London, W.

as Third Surveyor.

Surveyor to the Building Owner (Signature) Walter Smith
(Address) 30 Gray's Inn Square London W.C

Surveyor to the Adjoining Owner (Signature) F. Cooper
(Address) 9 Avenue Chambers, E.C

Dated this 16th day of March 1910

Fig. 14

MISCELLANEOUS REQUIREMENTS

GENERAL SUMMARY

115. Supplementary Constructional Provisions.—Section 207 of the Act of 1894 prohibits the alteration of a building without the consent of the Council, if by reason of such alteration it will not be in conformity with the provisions of the Act applying to new buildings. Section 208 provides that where a party or external wall, not in conformity with the Act, is taken down, burnt, or destroyed to the extent of one-half its superficial extent, every remaining portion of the old wall which is not in conformity with the Act must either be made to conform therewith, or must be taken down before the rebuilding of the wall is commenced. Section 209 provides that every addition to or alteration of a building, and any other work made or done in, to, or on a building, except that of necessary repair not affecting the construction of any external or party wall, shall be subject to the provisions of the Act relating to new buildings. Section 211 states that, unless the Council otherwise allow, the conversion of certain buildings in the manner specified in the section is not permissible.

116. Dangerous Structures.—Part IX of the Act of 1894 deals with dangerous and neglected structures. The term *structure* is defined, for the purpose of this part of the Act, as including any building, wall, or other structure, and anything affixed to or projecting from any building, wall, or other structure. When the Council receive information that a structure is dangerous, they are empowered to have a survey made of the structure by the district surveyor or some other competent surveyor. If the surveyor certifies that the structure is dangerous, the Council are empowered to serve a notice on the owner or occupier requiring him forthwith to take down, secure, or repair the same, as the case requires. They may also, at the same time, shore up and board in the structure, if necessary. If the owner of the structure disputes the necessity of the Council's

requirements, he may, within 7 days from the receipt of the Council's notice, require that the subject be referred to arbitration, and at the same time appoint an independent surveyor to report on the structure in conjunction with the surveyor appointed by the Council. The surveyors, before considering the question, must appoint a third surveyor, and if the two surveyors do not agree, this third surveyor will act as arbitrator, and decide all questions in dispute and determine what works are to be executed.

117. If the owner, however, does not refer the case to arbitration and does not comply with the Council's notice, the Council may take out a summons in the police court, and the Court, after hearing the case, may make an order, stating the works to be done and the time within which they must be completed. If the works specified in the order are not carried out, the Council themselves may carry out the work and recover the expenses from the owner. In any case, the Council are able to recover from the owner the fees paid by them to the district surveyor or other surveyor employed by them to survey and report on a structure which is considered by such surveyor to be dangerous. The amount of such fees is given in the Third Schedule to the Act.

118. Neglected Structures.—The latter portion of Part IX of the Act of 1894 deals with neglected structures. Section 115 provides that, where a structure is ruinous or so far dilapidated as to have become unfit for use or occupation, or is, from neglect or otherwise, in a structural condition prejudicial to the property in the neighbourhood, the Council may bring the case before a police court, and the Court may order the owner to take down or repair or rebuild such structure, or fence in the ground on which it stands, or otherwise put the structure into a state of repair and good condition to the satisfaction of the Council, within a time fixed by the order. If the required work is not carried out within the specified time, the Council may do the work and recover the expenses from the owner.

119. Dangerous and Noxious Businesses.—Part X of the Act of 1894 deals with the establishment and conduct of dangerous

and noxious businesses and the erection of buildings in the vicinity of such businesses. Section 118 provides that no person may erect a building nearer than 50 feet to a building used for any dangerous business, and that no person may establish or carry on a dangerous business within 40 feet of any public way or within 50 feet of any other building or any vacant ground belonging to any person other than his landlord. Section 119 provides that no person shall erect a dwelling house nearer than 50 feet to a building used for any noxious business, and a noxious business shall not be established or carried on in any building or vault or in the open air within 40 feet of a public way or 50 feet of any dwelling house. The Act defines what are dangerous businesses and what are noxious businesses, and contains special provisions allowing the re-erection of buildings erected prior to 1844, despite the general requirements as to the position of such businesses in relation to buildings.

120. Dwelling Houses in Low-Lying Land.—The erection of dwelling houses on land which is below the level of Trinity high-water mark, and which is so situate as not to admit of being drained by gravity into an existing sewer of the Council, is regulated by the provisions of Part XI of the Act of 1894. **Trinity high-water mark** is 12 feet 6 inches above Ordnance datum. Dwelling houses must not be erected on such land except with the consent of the Council, who, in coming to a determination in any case, will be governed by the opinion of their chief engineer.

121. Exempted Buildings.—A very considerable number of buildings are either wholly or partly exempted from the Act of 1894. These are given in Sections 201, 202, and 204, which, particularly Section 201, should be carefully studied by all who desire to become properly acquainted with the London building law. The exempted buildings are divided into three classes: buildings exempt from Parts VI and VII of the Act, buildings exempt from so much of the provisions of the Act as relates to buildings and structures, and lands and buildings exempt from the whole Act, except Part III. Subsections 11 and 12 of Section 201 are of very great importance, as these allow the

erection of a building of considerable size uncontrolled by the ordinary constructional requirements of the Act if such building is erected in an isolated position.

122. Service of Notice by Builder.—All the detailed requirements as to the construction of ordinary buildings are administered by the local district surveyor. It is thus necessary for him to know when any work is put in hand, and the Act provides that the district surveyor shall receive notice of the commencement of every important work. Section 145 of the Act deals with this question as follows :

In the following cases and at the following times, that is to say,

(*a*) Where a building or structure or work is about to be begun, then 2 clear days before it is begun ; and

(*b*) Where a building or structure or work is, after the commencement thereof, suspended for any period exceeding 3 months, then 2 clear days before it is resumed ; and

(*c*) Where, during the progress of a building or structure or work, the builder employed thereon is changed, then 2 clear days before a new builder enters upon the continuance thereof ;

the builder, or other person causing or directing the work to be executed, shall serve on the district surveyor a building notice respecting the building or structure or work.

Every building notice shall state the situation, area, height, number of stories, and intended use of the building or structure, and the number of buildings or structures if more than one, and the particulars of the proposed work, and the name and address of the person giving the notice, and those of the owner then in possession of, and the occupier of, the building or structure, or of its site or intended site.

All works in progress at the same time to, in, or on the same building or structure may be included in one building notice.

Notice forms to be filled in and served in compliance with Section 145 may be obtained at the office of the local district surveyor. A building notice form is invariably filled in by the builder and not by the architect.

123. Service of Notices by District Surveyor.—If it appears from the building notice served on the district surveyor that the requirements of the Act are proposed to be contravened, he is required by Section 150 to serve on the builder a notice termed a *notice of objection*. If the builder is dissatisfied with the decision of the district surveyor, he may, within 14 days

from the receipt of the notice of objection, appeal to the police court, and the Court may make an order either affirming the objection or otherwise. Should the district surveyor, in inspecting the carrying out of any work, find that the Act is being contravened, or, in a case where the proper building notice has not been given, should he find the work to be so far advanced that he cannot ascertain whether or not the Act has been complied with, it will be his duty to serve on the builder a notice termed a *notice of irregularity*. This notice may require the builder, within 48 hours, either to amend anything done in contravention of the Act, or to do anything required by the Act which has been omitted to be done, or to cause so much of the work as prevents the district surveyor from ascertaining whether or not the Act has been complied with, to be cut into, laid open, or pulled down. If the works required by the notice of irregularity are not carried out, the district surveyor may make complaint to a police court, and the Court may make an order requiring the requisitions of the notice, or such of them as appear to the Court to be authorized by the Act, to be complied with.

124. Rules as to Service of Notices.—Section 188 of the Act of 1894 provides that any notice or order required or authorized to be served under the Act may be served by delivering a copy at, or by sending a copy by post in a registered letter to, the usual or last-known residence in the United Kingdom of the person to whom the notice is addressed, or by delivering a copy of the notice to some person on the premises to which it relates, or, if no person is found on the premises, then by fixing a copy of the notice on some conspicuous part of the building to which it relates. In the case of a railway company, it is specially provided that service is to be made by delivering a copy of the notice to the secretary at the principal office of the company.

125. Payment of Fees.—It is provided by Section 157 of the Act of 1894 that fees are to be paid to the district surveyor by the builder employed in carrying out the work. The amount of the fees payable as regards any particular work is regulated by the Third Schedule of the Act, which should be consulted in

any case when the question of fees is under consideration. The schedule shows that the amount of the fees varies in accordance with the area and the number of stories in the building, that the fees are increased by one-half in the case of public and other specified buildings, and that additional fees are payable for certain special works. Where additions or alterations are carried out, the fee is one-half what would be charged in the case of a new building.

126. Minor Provisions. — Among the remaining provisions of the Act of 1894, which are not of sufficient importance to demand detailed mention, are those of Part IV, with regard to the naming and numbering of streets ; those of Part XII, which prohibit the erection or retention of sky signs as defined in Section 125 ; those of Part XIV, as to by-laws ; and those of Part XV, as to legal proceedings. It is worthy of notice that, although the Act gives the Council power to make by-laws with regard to the matters specified in Section 164, no such by-laws have been made, those made under the Acts existing prior to 1895 being still in force.

LONDON BUILDING LAW

(PART 2)

LONDON BUILDING ACTS (AMENDMENT) ACT, 1905

APPLICATION OF ACT

DEFINITIONS

1. Principal Amendment of Building Act of 1894.—The London Building Act (Amendment) Act, 1898, is of comparatively slight importance. Those of its provisions that affect general building work have been dealt with in *London Building Law*, Part 1. The most important legislative measure that amends the main Act of 1894 is the London Building Acts (Amendment) Act, 1905. This enactment deals almost exclusively with the question of means of escape in case of fire, and applies to all buildings of a specified height or accommodation except common lodging houses and factories and workshops in which more than 40 persons are employed. These particular buildings come within the scope of, respectively, the London County Council (General Powers) Act, 1902, and the Factory and Workshop Acts, 1901 and 1907.

2. Importance of Definitions.—In dealing with any Act of Parliament, it is essential, first of all, to consider the definitions. There are fewer than a dozen definitions in the Act under consideration, but practically all of them are of very considerable

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importance. As regards other words and expressions, it is provided that, unless the context otherwise requires, they are to bear the meanings assigned to them in the Act of 1894. The first definition is contained in Section 5 of the Act of 1905, it being there provided that, unless the context otherwise requires, the expression **fire-resisting material,** when used in the Acts of 1894, 1898, and 1905, means any of the things described or referred to in the First Schedule to the last-mentioned Act.

3. Definition of Owner.—It should be especially noted that the definition of the term *owner* is in all ordinary cases entirely different from the definition in the Act of 1894. The **owner** is defined in the Act of 1905 as being the person receiving the *rack rent* of the premises, and the term **rack rent** is defined as being rent which is not less than two-thirds of the full annual value of the premises. The meaning of the term *full annual value* is also explained. In the case, however, of the section relating to the payment of fees to district surveyors, it is provided that the term owner is to bear the interpretation given in the Act of 1894.

4. Definitions of Upper Story and High Building.—There are three definitions on which the whole application of the Act depends, and these will be quoted at full length. The first is the definition of **upper story,** which is as follows :

> The expression upper story means any story the level of the upper surface of the floor whereof is at a greater height than 50 feet above the level of the footway, if any, immediately in front of the centre of the face of the building in which such story is situate, or, where there is no such footway, above the level of the ground before excavation.

The second important definition is that of **high building,** with which must be read the definition of upper story :

> The expression high building means any building any story whereof is an upper story as hereinbefore defined.

5. Definition of New Building.—The third important definition is that of **new building,** given as follows :

> The expression new building means any building the actual erection of which, above the footings, shall not have been bona fide and substantially commenced at the date of the commencement of this Act, or which

has been taken down, burnt, or destroyed for more than one-half of its cubical extent and re-erected or commenced to be re-erected after such date, or of which the cubical extent has been increased after such date by an amount equal to the cubical extent of the building as existing before such increase, and any existing building which by reason of any alteration thereof, or addition thereto, becomes a high building after such date.

It will be observed that this definition of the term new building is very different from that in the Act of 1894. The term **existing building**, which is frequently used, is concisely defined as meaning any building not being a new building.

PRINCIPAL PROVISIONS OF ACT

6. Principal Sections.—The principal requirements of the Act are contained in six sections, namely, Sections 7, 9, 10, 11, 12, and 13. Section 7 deals with the means of escape from the upper stories of new buildings, the term upper story being here used as defined, and from new buildings occupied by more than 20 persons. Section 9 deals with the means of escape from existing buildings of a similar kind. Section 10 requires the fireproofing of the roofs of projecting shops, both new and old, when the projection is 7 feet or more. Section 11 deals with the use of living-rooms over, or directly communicating with, premises used for the storage of inflammable liquid. Section 12 deals with the provision of means of access to roofs in buildings of an ordinary character. Section 13 prohibits the conversion of buildings, without consent, in such a manner that they will not be in conformity with the provisions of the Act. A thorough grasp of the requirements of these sections will help materially to obtain a knowledge of all the vital points in the Act.

7. Sections Dealing With Administration.—There are numerous sections dealing with questions of administration. The general administrative body are the London County Council, but the district surveyors are also directly concerned in the administration of the Act. The duties of district surveyors under the Act are set forth in Section 16. In Section 17 it is provided that the district surveyors are to notify the Council in certain cases, and

Section 18 states that they are to receive the fees specified in the Second Schedule of the Act.

8. Rights of Owners and Occupiers.—The question of the rights and liabilities of owners and occupiers of premises also receives attention. Section 15 provides that, for the purpose of executing or maintaining work required by the Act, the owner of premises may enter the premises and do the necessary work notwithstanding any provision to the contrary in the lease or contract under which the tenant holds the building. Section 20 contains provisions whereby an owner who has executed work may require a part of the expenses borne by him to be apportioned among such other persons as have an interest in the property. Section 21 provides that where an occupier claims that he has sustained damage in consequence of the construction of works carried out under the Act, his claim is to be referred to arbitration.

9. Appeals and Exemptions.—In Section 22 there is a statement of all the cases under the Act in which there is the right of appeal. The body to whom appeal is to be made are the Tribunal of Appeal as constituted under the Act of 1894. There are also numerous classes of buildings that are exempt from the Act. Section 34 provides that any new or existing building used or intended to be used to the extent of not less than three-fourths of its cubical extent as a bank or insurance office by not more than two companies or firms, and, as regards the remainder of its extent, used or intended to be used only as a residence for, or for providing sleeping accommodation for, officers or servants of such companies or firms, is exempt from the Act. Buildings the property of the Inns of Court are exempt from the Act in all cases. Bonded warehouses, the buildings of public wharfingers, buildings the property of the Crown, and, in general, buildings belonging to railway, dock, gas, and electric-lighting companies, are also, in all ordinary cases, exempt. A public wharfinger is defined as being an owner, lessee, or occupier of a wharf, quay, warehouse, or granary adjoining the port of London, that is mainly used for warehousing imported goods which are the property of persons other than the occupier of the premises.

DETAILS OF PRINCIPAL REQUIREMENTS OF ACT

REQUIREMENTS AS TO NEW BUILDINGS

10. Submission of Plans to County Council.—Under the provisions of Section 7 of the Act, a person erecting a building of any importance in London is required to submit plans to the County Council and obtain their consent to the means of escape proposed. The first part of this very important section is as follows :

> Every new building, except a dwelling house occupied as such by not more than one family, which is
>
> (*a*) A high building ; or
>
> (*b*) A building in which sleeping accommodation is provided for more than 20 persons, or which is occupied or constructed or adapted to be occupied by more than 20 persons, or in which more than 20 persons are employed, or which is constructed or adapted for the employment therein of more than 20 persons ;
>
> shall be provided in accordance with plans approved by the Council, or, in the event of an appeal, the Tribunal of Appeal, with all such means of escape therefrom in case of fire as can be reasonably required under the circumstances of the case. The owner of the building shall, before or at the same time that the building notice under section 145 (Notices to be given to surveyor by builder) of the Act of 1894 in respect of such building is served on the district surveyor, deposit or cause to be deposited at the county hall a notice stating the like matters and particulars as are required by the last-mentioned section to be stated in a building notice thereunder, together with a copy, which may be a sun-print or photographic reproduction on paper, of the plans prepared for such new building, showing, so far as may be necessary for the purposes of this Act, the means of escape proposed to be provided in connection with such building.

11. Consent of County Council.—The County Council, however, are not able greatly to delay the commencement of the building operations while they are coming to a decision ; the Act provides that, if they do not refuse to approve the plans within a stated time, they will be deemed to have given their approval. The text of this provision is as follows :

> It shall be lawful for the Council, at any time within the period of 1 month, or in the event of such period of 1 month commencing or expiring on any day between August 1 and September 14, both inclusive, then

within the period of 2 months, after the deposit as aforesaid of such plans, to refuse to approve such plans or to approve the same subject to such conditions, if any, as they may prescribe; provided that the Council shall within such period as aforesaid give notice to the applicant of such refusal or conditional approval, stating fully all their reasons for such refusal or for the imposition of such conditions, as the case may be. Provided that, if within the period limited as aforesaid, the Council fail to give notice of their refusal to approve any such plans, or of the conditions subject to which they approve any such plans, they shall be deemed to have approved such plans without conditions.

12. Prohibition of Occupation Without Consent.—No upper story in any new high building, and no part of any new building which is a building of the nature described in paragraph (*b*) in Art. **10,** may be occupied or let for occupation until the Council shall have issued a certificate, or, in the event of appeal, until the Tribunal of Appeal shall have determined that the building has been properly provided with means of escape. In the event, however, of the Council refusing to issue a certificate, they are required by the Act, within 14 days after notice of the completion of the building has been given to them, to notify the owner that the certificate has been refused and the grounds of such refusal. If they fail to do this, the certificate will be deemed to have been duly issued. The owner of any building in respect of which a certificate is refused may appeal to the Tribunal of Appeal.

13. Alterations to Certified Buildings.—The remaining portion of Section 7 deals with the question of alterations to existing buildings. It is provided that if, in any certified building, the sleeping accommodation is increased, or if the number of persons occupying or employed in the building are increased, or if there is a material change in the use of the building, or if by reason of any change of circumstances the risk of fire is substantially increased or the escape from the building rendered substantially more difficult, then, in any of such cases, the certificate is to be of no effect and the building is to be deemed an existing building. As an existing building it can of course be dealt with by the Council under the provision of Section 9.

14. Scope of Requirements as Regards High Buildings.—It is specially provided in the last subsection of Section 7 that

unless a high building is also a building of the nature described in paragraph (*b*) in Art. **10** the Council are not entitled to require any means of escape from any story other than an upper story. This applies also, in the case of alterations, to certified buildings. No increase in accommodation or number of persons, or in the risk of fire or difficulty of escape, will have the effect of rendering the certificate of a high building null and void unless one or more of the upper stories is affected. It seems clearly the intention of the Act in this and other cases to deal exclusively with the upper stories of high buildings, provided that such buildings are not buildings of the nature described in paragraph (*b*) in Art. **10.**

15. Occupation of Buildings During Rebuilding.—It is provided in Section 8 that the requirements of Section 7 as to the unlawfulness of the occupation of new buildings without a certificate is not to prevent the continuous occupation during the rebuilding of any portion of any building to which this requirement applies and which has been partially taken down, burnt, or destroyed. It will be seen from this that the interests of occupiers are considered by the Act. Generally speaking, it may be said that throughout the detailed requirements of this Act the interests of private individuals receive more consideration than is the rule in Acts of Parliament, but, on the other hand, a few of the principal requirements are exceptionally stringent.

REQUIREMENTS AS TO EXISTING BUILDINGS

16. Service of Notice by Council. — Section 9 of the Act contains very far-reaching requirements in respect of the provision of means of escape in case of fire from existing buildings. The text of the first portion of the section is as follows:

> From and after January 1, 1907, in the case of any existing building, except a dwelling house occupied as such by not more than one family, which is
>
> (*a*) A high building; or
>
> (*b*) A building in which sleeping accommodation is provided for more than 20 persons, or which is occupied by more than 20 persons, or in which more than 20 persons are employed;
>
> the Council, if in their opinion such building is not provided with proper and sufficient means of escape therefrom in case of fire, may at any time

serve on the owner of such building a notice requiring him to provide such means of escape as can be reasonably required under the circumstances of the case.

17. Rights of Owner as to Appeal.—The next portion of Section 9 deals with the rights of an owner who is served with a notice under the section.

Any such notice shall specify in detail the requirements of the Council, and the owner of such building shall, subject to the provisions of this Act, execute and do all such works and things as may be necessary in order to comply with any requirements made by the Council under this section, and, in the event of an appeal, confirmed or varied by the Tribunal of Appeal as hereinafter provided, within such period as may be required by the Council or, in the event of an appeal, the Tribunal of Appeal. Provided that, if such owner shall within 21 days after the service of such notice have submitted to the Council alternative proposals for the provision of means of escape in case of fire, and the Council shall have, in writing, accepted the same as satisfactory, it shall not be necessary for such owner to comply with any of the requirements contained in the notice served on him by the Council as aforesaid, but he shall, with all practicable dispatch after such acceptance as aforesaid, execute and do all such works and things as may be necessary in order to provide the means of escape specified in such alternative proposals.

From the above quotation it is seen that an owner is entitled to demand that the notice shall specify in detail the requirements of the Council, that he has the right of appeal, and that he also has the right, within 21 days from the time when the notice was served on him, to submit alternative proposals.

The remainder of the section deals with the action to be taken by the Council in the event of an owner failing to comply with their notice, and also provides that nothing in the section is to authorize the Council to require, in the case of a high building which is not a building of the class referred to in paragraph (*b*) of Art. **16**, the provision of means of escape from any story other than an upper story.

18. Scope of Section 9 of Act.—It is evident that there are a very large number of existing buildings in London of the nature described in paragraphs (*a*) and (*b*) in Art. **16**, and as the section applies to all such buildings, except dwelling houses occupied by a single family, its scope is a very wide one. It must not be supposed, however, that the Council are immediately putting in

force their powers under this section in respect of every building to which the section applies. The work of dealing with such buildings proceeds gradually, and it is probable that it will be very many years before all the buildings that come within the scope of the section will have been dealt with.

REQUIREMENTS AS TO BOTH NEW AND EXISTING BUILDINGS

19. Projecting Shops.—Section 10 deals with the construction of the roofs of shops, both new and old, that project 7 feet or more beyond the face of the buildings of which they form part. The roofs over such projecting shops are required by the section to be constructed of fire-resisting materials not less than 5 inches thick. The construction of lantern lights and ventilating cowls in the roofs of such shops is, however, permitted, subject to the following restrictions :

> Provided that no such lantern light or ventilating cowl shall be constructed or placed so that any part thereof will be at a less distance than 6 feet from the main front of the building from which the shop projects, or within such distance as may be reasonable in the circumstances of the case from any other external or party wall. Provided also that the sides of such lantern light or ventilating cowl, except the side facing away from the main building, shall be carried up in fire-resisting materials for 2 feet above the roof in or upon which it is constructed or placed. Provided, further, that no part of any such lantern light or ventilating cowl shall project above the roof in or upon which the same is constructed or placed to a greater extent than 5 feet.

It is provided in the last subsection of Section 10 that the Council, or, in the event of an appeal, the Tribunal of Appeal, may, in any case where it is reasonable to do so, sanction, subject to such conditions, if any, that they may respectively desire to impose, the exemption of any building from all or any of the provisions of the section.

20. Rooms Adjoining Stores of Inflammable Liquid. — Section 11 provides that, except in accordance with specified conditions, no person shall use, or permit to be used, either as a living-room or as a workshop or workroom, any room constructed over, or communicating directly with, any part of a building

used for the storage of petroleum or certain specified inflammable liquids or any other inflammable liquid kept for sale or trade purposes in such manner as to be liable to cause fire or explosion. The conditions under which the use of such a room is permitted are that there be provided in connection with such room, according to the requirements and to the satisfaction of the Council, the following :

(i) Adequate safeguards to prevent the spread of fire from the part of the building used for the storage of any such inflammable liquid to such room ; and

(ii) Means of ready escape from such room in case of fire.

21. Means of Access to Roofs.—The provision of means of access to roofs is dealt with in Section 12. The requirements of the section apply to every existing building that comes within the scope of Section 10, every other existing building except a dwelling house occupied as such by not more than two families, and every new building, if, in any of these three cases, the building has more than 2 stories above the ground story, or exceeds 30 feet in height. There are alternative means by which access may be provided as follows :

(*a*) A dormer window or a door opening in a suitable position approved by the district surveyor on to the roof, with proper access thereto ; or

(*b*) A trap-door in a suitable position approved by the district surveyor covered with copper or zinc, and hung on hinges so as to admit of the same opening to the fullest extent, and furnished with a counterweight so as to ensure that the same shall open automatically when unfastened, and also with a fixed or hinged step ladder leading to the roof ; or

(*c*) Other proper means of access to the roof.

In addition, a sufficient parapet or guard rail must be provided, where reasonably practicable and necessary, to prevent persons from slipping off the roof. Any dormer or trap-door provided is only to be fastened in such a manner as to ensure access to the roof being always readily available from the inside of the building. The Council, or, in the event of appeal, the Tribunal of Appeal, may, in any case where it is reasonable to do so, sanction, subject to such conditions, if any, as they may desire, the exemption of any building from all, or any, of the provisions of the section. The section does not apply to buildings which come within the scope of Sections 7 and 9.

22. Conversion of Buildings.—Section 13 provides that no person shall, without the consent of the Council, or, in the event of appeal, of the Tribunal of Appeal, convert a building in such a manner that when converted it will not be in conformity with the Act. It is provided, however, that if within a stated period, usually 1 month, the Council, after having received written application for consent to convert a building, do not notify the owner that consent is refused, and the grounds of such refusal, they will be deemed to have given consent. For the purposes of the section the term **convert** is to include any change of use as regards the building, whether or not involving any structural alteration. Notice of the proposed conversion of a building is to be given to the district surveyor by the owner or occupier of the building.

RIGHTS OF APPEAL TO TRIBUNAL

23. A summary of the cases in which it is possible under the Act to appeal to the Tribunal of Appeal is given in Section 22. The sections under which appeal is possible are Sections 7, 9, 10, 11, 12, and 13, these being the principal sections of which the requirements are quoted in Arts. **10** to **22**. In making an appeal, it is necessary to comply with the requirements contained in the Regulations of the Tribunal, a copy of which may be obtained at the office of that body. Appeals are required to be lodged within 14 days after notice of the decision certificate or requirement appealed against has been given to or served on the appellant.

SCHEDULE OF FIRE-RESISTING MATERIALS

24. The schedule of fire-resisting materials given in the Act of 1905, which schedule applies throughout all the Building Acts, is as follows :

(I) For general purposes :

(1) Brickwork constructed of good bricks, well burnt, hard and sound, properly bonded and solidly put together

(*a*) With good mortar compounded of good lime and sharp clean sand, hard clean broken brick, broken flint, grit, or slag ; or

(*b*) With good cement ; or

(*c*) With cement mixed with sharp clean sand, hard clean broken brick, broken flint, grit, or slag;

(2) Granite and other stone suitable for building purposes by reason of its solidity or durability;

(3) Iron, steel, and copper;

(4) Slate, tiles, brick, and terra-cotta, when used for coverings or corbels;

(5) Flagstones, when used for floors over arches, but such flagstones not to be exposed on the under side and not supported at the ends only;

(6) Concrete composed of broken brick, tile, stone chippings, ballast, pumice, or coke breeze, and lime, cement, or calcined gypsum;

(7) Any combination of concrete and steel or iron.

(II) For special purposes:

(1) In the case of doors and shutters and their frames, oak, teak, jarrah, karri, or other hard timber, not less than $1\frac{3}{4}$ inches finished thickness, the frames being bedded solid to the walls or partitions;

(2) In the case of staircases and landings, oak, teak, jarrah, karri, or other hard timber, the treads, risers, strings, and bearers being not less than $1\frac{3}{4}$ inches finished thickness, and the ceilings and soffits, if any, being of plaster or cement;

(3) Oak, teak, jarrah, karri, and other hard timber when used for beams or posts, or in combination with iron, the timber and the iron, if any, being protected by plastering or other incombustible or non-conducting external coating not less than 2 inches in thickness, or, in the case of timber, not less than 1 inch in thickness, on iron lathing;

(4) (*a*) In the case of floors and roofs:

Brick, tile, terra-cotta, or concrete, composed as described in paragraph (I) (6) of this schedule, not less than 5 inches thick, in combination with iron or steel;

(*b*) In the case of floors and of the roofs of projecting shops:

Pugging of concrete composed as described in the said paragraph (I) (6), not less than 5 inches thick between wood joists, provided a fillet 1 inch square is secured to the sides of the joists and placed so as to be in a central position in the depth of the concrete; or concrete blocks not less than 5 inches thick, laid between wood joists on fire-resisting bearers secured to the sides of joists;

(5) In the case of verandas, balustrades, outside landings, the treads, strings, and risers of outside stairs, outside steps, porticoes, and porches, oak, teak, jarrah, karri, or other hard timber not less than $1\frac{3}{4}$ inches finished thickness;

(6) In the case of internal partitions enclosing staircases and passages, terra-cotta, brickwork, concrete, or other incombustible material not less than 3 inches thick;

(7) In the case of glazing for windows, doors, and borrowed lights, lantern, or skylights, glass not less than $\frac{1}{4}$ inch in thickness in direct

combination with metal the melting point of which is not lower than 1,800° F., in squares not exceeding 16 square inches and in panels not exceeding 2 feet across either way, the panels to be secured with fire-resisting materials in fire-resisting frames of hard wood not less than $1\frac{3}{4}$ inches finished thickness, or of iron.

(III) Any other material from time to time approved by the Council as fire resisting.

LONDON COUNTY COUNCIL (GENERAL POWERS) ACTS

ACT OF 1902

REQUIREMENTS AS TO COMMON LODGING HOUSES

25. Licence to Keep Common Lodging House.—The law with regard to common lodging houses may be considered for all practical purposes to be contained in Part IX of the London County Council (General Powers) Act, 1902. This Act provides that no person may keep a common lodging house unless he has applied for and obtained a licence from the Council. Licences are valid for the period of 1 year, and are renewable from year to year.

26. Application for Licence.—The Council are required by Section 47, as soon as practicable after an application has been made to them, to cause all necessary inspections and inquiries to be made as to whether the person applying is a fit and proper person to have the management of a common lodging house, and whether the premises in respect of which the application is made are structurally and otherwise suitable for use and occupation as a common lodging house, having regard to the number, health, safety, and convenience of the persons intended to occupy the same. If the Council are satisfied, they will issue a licence, which is required by Section 48 to specify the maximum number of lodgers who may at any one time occupy the premises.

27. Appeal Against Refusal of Licence.—Should the Council refuse to grant a licence, they may be required by the

applicant, under the provisions of Section 50, to give him a statement, in writing, of the grounds on which the licence is refused. The applicant may then, if he so desires, appeal to the police court of the district at any time within 14 days after the date of the refusal, provided that not less than 24 hours' notice of the appeal is given to the Council. If the licence is refused on the ground that the premises are not suitable, the magistrate has power to appoint a properly qualified surveyor or architect to examine and report to him on the condition of the premises and their suitability for the purposes of a common lodging house. There is a similar right of appeal in the case of the refusal of the renewal of a licence.

ACT OF 1908

SUBDIVISION OF BUILDINGS

28. Repeal of Requirements of Act of 1894.—Sections 75 to 77 of the Building Act of 1894, which relate to the cubical extent of buildings and the uniting of buildings, were repealed by the London County Council (General Powers) Act, 1908. This Act contains requirements of a more stringent character in substitution of those repealed. These requirements are given in Part III of the Act, the sections in which the principal provisions occur being Sections 17 to 19. The requirements are of a very important nature, as they affect the majority of large buildings, other than office and public buildings, that are erected in London.

29. Cubical-Extent Requirements.—The requirements of Section 17 as to the subdivision of buildings of a specified character are as follows :

Except as in this section provided, no building of the warehouse class, and no building or part of a building used for any trade or manufacture, shall extend to more than 250,000 cubic feet unless divided by division walls in such manner that no division of such building or part of a building, as the case may be, shall extend to more than 250,000 cubic feet, and no addition shall be made to any such building, part of a building, or

division so that the cubical extent of such building, part of a building, or division shall exceed 250,000 cubic feet.

The cubical extent must be measured in the manner described in Section 5 of the Act of 1894. It is important to notice that the walls and roof of a building are required to be included in taking measurements for cubical-extent calculations.

30. Consent to Additional Cubical Extent.—Previously to the passing of the Act, the Council's power to consent, under the Act of 1894, to increased cubical extent was subject to several restrictions. Now, however, the Council have unlimited powers in this direction, as the following shows :

Where the Council are satisfied, on the report of the superintending architect and of the chief officer of the fire-brigade, that additional cubical extent is necessary for any such building, part of a building, or division, as aforesaid, and are satisfied that proper arrangements have been or will be made and maintained for lessening, so far as reasonably practicable, danger from fire, the Council may consent to such building, part of a building, or division containing additional cubical extent ; but such consent shall continue in force only while such building, part of a building, or division is actually used for the purposes of the trade or manufacture, if any, in respect of which the consent was granted.

The Council have also power, both in ordinary cases and in cases where additional cubical extent is allowed, to consent to buildings being wholly or in part subdivided horizontally by floors, instead of by *division walls*. A floor provided for this purpose must be constructed in every respect to the satisfaction of the Council.

31. Buildings Exempt From Requirements.—It is stated that the provisions of the section are not to apply to any building, situated at a greater distance than 2 miles from St. Paul's Cathedral, which is used wholly for the manufacture of machinery and boilers of steam vessels, or for a retort house, or for the manufacture of gas, or for generating electricity. The exemption, however, only applies to buildings consisting of one floor and constructed of brick, stone, iron, or other incombustible material throughout. Such buildings as are thus exempted are required by the section to be special buildings to which the general provisions of Part VI of the Act of 1894 are inapplicable.

Consequently, they will come within the scope of the provisions of Part VII of such Act.

32. Rules as to the Uniting of Buildings.—The requirements of Section 18 with regard to the uniting of buildings are as follows:

Buildings shall not, without the consent of the Council, be united unless (*a*) they are wholly in one occupation, and (*b*) when so united and considered as one building they would be in conformity with the principal Act, as amended by this part of the Act, and with this part of this Act.

The Act referred to as the principal Act is the London Building Act, 1894. It will be seen that unless buildings are wholly in one occupation the Council's consent is required before they can be united. This fact is by no means as well known as it should be. The provisions apply to all openings proposed to be made in any division or party wall, notwithstanding that there may already be openings in such wall.

33. Rules as to Openings.—Whenever an opening is made in any division wall separating cubical-extent divisions, or in any party wall or two external walls separating buildings, if the divisions or buildings, as the case may be, that are united by such opening would, taken together, exceed 250,000 cubic feet, the following conditions must be complied with:

(*a*) Such opening shall have the floor jambs and head formed of brick, stone, iron, or other incombustible materials, and be closed by two wrought-iron doors, sliding doors, or shutters, each not less than $\frac{1}{4}$ inch thick in the panel, at a distance from each other of the full thickness of the wall, fitted to grooved or rabbeted iron frames without woodwork of any kind; and all such doors, sliding doors, and shutters shall be fitted with sufficient and proper bolts or other fastenings and be capable of being opened from either side, and shall have on each face thereof stiles and rails at least 4 inches wide and $\frac{1}{4}$ inch thick, and shall be constructed, fitted, and maintained in an efficient condition. Provided that, in lieu of being constructed and fitted as aforesaid, such doors, sliding doors, and shutters may be constructed of any such fire-resisting materials and be fitted in any such manner as may be approved by the Council;

(*b*) Such opening shall not exceed in width 7 feet or in height 8 feet, and the width of such opening in any wall of a story, or, if there be more than one such opening in any such wall, the width of all such openings taken together, shall not exceed one-half of the length of such wall. Provided that any such opening may be 9 feet 6 inches in height in a wall

of which the thickness is not less than 24 inches, or if the doors, sliding doors, or shutters closing such opening are placed at a distance of not less than 24 inches from each other. Provided also that the Council may consent to any such opening being of such greater height or width as they may think fit.

34. Materials of Doors and Size of Openings.—Under the repealed provisions of the Act of 1894 the only permissible material of which doors closing openings might be constructed was wrought iron, and the maximum allowable size of opening was 9 feet 6 inches high by 8 feet wide. Under the new provisions the use of doors of other materials is permissible if the consent of the Council is obtained. Also, the old limit to the size of openings does not apply; the Council have power to consent to openings of any size that they may think fit.

35. Discontinuance of Single Occupancy.—It is further provided in Section 18 that, whenever any buildings which have been united cease to be in one occupancy, notice must be given of the change of occupancy to the district surveyor. All openings uniting the buildings must be stopped up unless the Council consent to their being retained. The material to be used for stopping up openings is brick or stonework not less than 13 inches in thickness, except as regards openings in walls $8\frac{1}{2}$ inches in thickness, in which case $8\frac{1}{2}$ inches is sufficient. The material used for stopping up an opening must be properly bonded with the material of the wall in which the opening is made, in order that a proper resistance to fire may be afforded.

36. Construction of Division Walls.—The construction of division walls is dealt with in Section 19. It is there stated that the provisions of the Building Act of 1894 with respect to party walls are to extend and apply to division walls. It is provided, however, that the Council may consent to such departure as they may think expedient from such of these provisions as are contained in Part VI and the First Schedule to the Act. It would thus appear to be permissible to apply to the Council for consent to such matters as a reduction of the thickness of walls, or a reduction of the height to which walls are in ordinary cases required to be carried above the roof.

ACT OF 1909

CONSTRUCTION OF STEEL-FRAME BUILDINGS

37. Amendment of Part VI of Act of 1894.—Part IV of the London County Council (General Powers) Act, 1909, which deals both with steel-frame and reinforced-concrete construction, is stated by Section 24 of the Act to form part of Part VI of the Building Act of 1894. The ordinary requirements as to the enclosing of buildings with walls of specified thickness that are contained in Part VI of the Act of 1894 are consequently no longer compulsory. A person now is able, if he so desires, to take advantage of the provisions of Part IV of the London County Council (General Powers) Act, 1909, and erect a building of steel-frame construction with thin panel walls.

38. Scope of Part IV of Act of 1909.—The provisions of Part IV of the London County Council (General Powers) Act, 1909, deal very thoroughly with the details of construction. Even in cases where it is not proposed to take advantage of the provisions of the Act, the requirements can be studied with advantage if any steel construction is involved, for they contain many sound constructional rules. There is only one section, namely, Section 22, that deals with the details of steel-frame construction, but this contains as many as 35 subsections and its provisions are of an exceedingly comprehensive character. Section 23 deals with reinforced-concrete construction, Section 25 with the constitution of the Tribunal of Appeal when hearing appeals under the Act, and Section 26, which is the last section of importance in Part IV, refers to the payment of fees to district surveyors.

39. Definitions in Act of 1909.—The definitions in Part IV of the Act are few in number and are therefore quoted in full, as follows :

For the purposes of this part of this Act the expression pillar shall, unless otherwise stated, mean a metal pillar, and shall include all columns and stanchions, or an assemblage of columns or stanchions, properly

riveted or bolted together; and the expression girder shall mean a metal girder or joist; and the expression Tribunal of Appeal means the Tribunal of Appeal as constituted by this part of this Act.

Other words and expressions, unless the context otherwise requires, are to bear the meanings assigned to them in the Building Acts of 1894, 1898, and 1905, and in the London County Council (General Powers) Act, 1908.

40. General Construction and Materials. — All the requirements that will be quoted with regard to the details of steel-frame construction will be found in Section 22. All rolled steel used is to comply with the British standard specification for structural steel for bridges and general building construction. Every pillar or girder is to be of iron or steel or other structural metal which may be standardized by the Engineering Standards Committee. The skeleton framework of a building erected in accordance with Part IV of the London County Council (General Powers) Act, 1909, must, in conjunction with the party walls, be capable of safely sustaining the whole dead load. It is therefore not permissible to consider the brickwork used in any external enclosures as being capable of sustaining any load. The whole load on such part of the structure must be sustained by the steel framing.

41. Protection of Metal Work. — All the steel framework of a building erected under the provisions of the Act of 1909 must be protected from the effects of fire. The thickness of the protecting material varies considerably in accordance with the character of the member protected:

All pillars in the external walls of a building shall be completely enclosed and protected from the action of fire by a casing of brickwork, terra-cotta, concrete, stone, tiles, or other incombustible materials at least 4 inches thick, the whole being properly bonded or secured together:

All girders in the external walls of a building shall be similarly enclosed and encased with brickwork, terra-cotta, concrete, stone, tiles, or other incombustible materials at least 4 inches thick, properly tied and bonded or secured to the adjoining work, but the casing on the under side of such girders, and to the edges of the flanges thereof and plates and angles connected therewith, may be of any thickness not less than 2 inches:

All pillars and girders, other than pillars and girders in the external walls of a building, shall be protected from the action of fire by being

encased to the satisfaction of the district surveyor, and to a thickness of not less than 2 inches, in brickwork, terra-cotta, concrete, metal lathing, and plaster or cement, but the casing on the upper surface of the upper flange of all girders, and on the lower surface of all subsidiary joists, may be of any thickness not less than 1 inch. Wood furrings shall not be used in connection with any such casing. Provided that this subsection shall not apply in the case of buildings of only one story and not more than 25 feet in height.

42. Construction of Girders.—There are several useful constructional rules in relation to girders. Every girder is to be secured against buckling whenever its length exceeds 30 times the width of the compression flange, and the web of every girder is to be secured against buckling when the depth of the web exceeds 60 times the thickness. The span of a girder must not exceed 24 times the depth unless the calculated deflection of the girder is less than $\frac{1}{400}$ part of the span. Where girders are arranged side by side they are to be fixed together by iron separators and bolts or by riveted plates. Separators are to be spaced at distances not exceeding 5 times the depth of the girders to which they are attached, and are also to be placed immediately under all concentrated loads. Girders for supporting external walls are to be placed at the floor level of a story, or at a distance of not more than 5 feet above or below such floor level.

43. Use of Rivets.—The requirements relating to the use of rivets are of a sound practical character and worthy of close attention:

Rivets shall be used in all cases where reasonably practicable, but where bolts are used they shall extend through the full thickness of the nuts attached thereto, and the nuts shall in all cases be so secured as to avoid risk of their becoming loose. The distance from the edge of a rivet hole, or bolt hole, to the edge of the plate, bar, or member, shall not be less than the diameter of the rivet or bolt. Rivets shall be so placed that their centres shall not be closer together than 3 times the diameter of the rivets. The pitch of rivets shall be measured in one continuous straight line, and such straight-line pitch in girders, pillars, and roof-work shall not exceed 16 times the thickness of the thinnest plate, bar, or member through which they pass.

44. Construction of Walls.—One of the most important features in proper steel-frame construction is the use of very

thin external walls. As such walls act as enclosure walls only, and are not called on to bear any loads other than their own weight, it would be a waste of material to make them of any great thickness. This is recognized by the London County Council (General Powers) Act of 1909, the requirements being as follows:

> An external wall may be of any thickness not less than $8\frac{1}{2}$ inches for the topmost 20 feet of its height, and 13 inches for the remainder of its height below such topmost 20 feet. Provided that a less thickness shall be allowed in any case in which, under the London Building Act, 1894, such less thickness is prescribed, but that nothing in this subsection shall override any of the requirements of this section in regard to the thickness of casing in connection with pillars and girders, and that in any case in which an external wall or portion of an external wall is not supported or carried or secured by metal framework within the limits of height and length prescribed by the First Schedule to the London Building Act, 1894, for the purpose of determining the thickness of walls, such external wall or portion of external wall shall be of a thickness not less than that prescribed by such schedule.

Party walls, however, are required to be of the thickness prescribed by the Building Act of 1894. The brickwork of external walls is to be executed in Portland-cement mortar, and the cement must be in accordance with the British standard specification. The brickwork of party walls, exclusive of any parts immediately surrounding metal framework, and other internal brickwork not constructed to carry loads, may be built in lime mortar.

45. Construction of Pillars.—The requirements with regard to pillars deal with the use of steel, wrought iron, and cast iron. No plate or bar in any steel or wrought-iron pillar may be in any part less than $\frac{1}{4}$ inch in thickness. The joints between such pillars are to be close-butted joints with cover-plates properly riveted to connect the two members that are joined, and, unless unavoidable, no joint is to be made except at or near the level of a girder. The rivets in the base of a pillar must be sufficient to transmit the whole of the load on the pillar, through the gusset plates, to the base plates. This is, of course, essential in all good construction, whether or not carried out under the Act. Where any wrought-iron or steel pillars are built up

hollow, the cavities are required either to be filled up with concrete or to be covered over at both ends by riveted plates.

46. Provisions as to Pillars.—The width of every cast-iron pillar is required to be not less than 5 inches, and the thickness may not be less than $\frac{3}{4}$ inch or one-twelfth the least width of the pillar, whichever is the greater. All joints between pillars are to be made as near as reasonably practicable to the level of a girder, and the connection between the pillars is to be made by not fewer than 4 bolts of not less diameter than the least thickness of metal in the pillar. If more than 4 bolts are used, the diameter of the bolts may be reduced proportionately, but no bolt may be less than $\frac{3}{4}$ inch in diameter. The remaining provisions with regard to pillars deal with points in construction which will always receive attention in good work, whether or not it is carried out under this Act.

47. Miscellaneous Requirements. — It is provided that the stress in any metal interposed between the ends of a superimposed pillar and a pillar beneath must not exceed the stress on the superimposed pillar, and the least width across such interposed metal may not be less than the least width of the superimposed pillar. This requirement presumably deals with a case in which the pillars are not carried up continuously, but, instead, a steel joist is run through between the pillars.

All floors and staircases in buildings erected under the provisions of the General Powers Act of 1909 are required to be constructed of fire-resisting materials and to be carried on supports of fire-resisting materials. A list of such materials is given in the First Schedule to the Building Act of 1905, which schedule is quoted in Art. **24**. All structural metal work comprised in the skeleton framework of a building is required to be cleaned of loose rust and be thoroughly coated with one coat of boiled oil, tar, or paint before erection, and must receive at least one additional coat after erection. When, however, the metal work is to be encased in brickwork, concrete, or other similar incombustible materials, one coat of Portland-cement wash applied after erection may be used instead of the coats of oil, tar, or paint.

48. Superimposed Loads on Floors and Roofs.—The Act provides that for the purpose of calculating the loads on foundations and on the various portions of the steel-frame construction, the superimposed loads on floors and roofs are to be estimated as equivalent to the following dead load :

For a floor intended to be used wholly or principally for the purposes of human habitation or for domestic purposes, 70 pounds per square foot of floor area;

For a floor intended to be used wholly or principally for the purpose of an office or a counting-house, or for any similar purpose, 100 pounds per square foot of floor area;

For a floor intended to be used wholly or principally for the purpose of a workshop or retail shop, 112 pounds per square foot of floor area ;

For every floor in a building of the warehouse class not intended to be used wholly or principally for any of the purposes aforesaid, not less than 224 pounds per square foot of floor area. In every building of the warehouse class a notice shall be exhibited in a conspicuous place, on each story of such building, stating the maximum superimposed load per square foot which may be carried on the floor of such story ;

For a roof the plane of which inclines upwards at a greater angle than 20° with the horizontal, the superimposed load, which shall for this purpose be deemed to include wind pressure, shall be estimated at 28 pounds per square foot of sloping surface;

For all other roofs the superimposed load shall be estimated at 56 pounds per square foot measured on a horizontal plane.

It is further provided that if the superimposed load on any floor or roof is to exceed that specified for such floor or roof, the construction shall be made sufficiently strong to bear such loads.

49. Loads on Foundations and Pillars.—A special method of calculation is specified for obtaining the loads on foundations and pillars in buildings more than two stories in height. The superimposed loads for the roof and for the top story are to be calculated from the particulars quoted in Art. 48. Then, for the floor below the top floor, 95 per cent. of the load allowed on the top floor is to be taken ; for the next floor, 90 per cent. of the top-floor load is to be taken, and so on, working downwards floor by floor and deducting 5 per cent. of the original load for every floor below the top floor. If the building is of such a height that a floor is reached at which the load is so reduced that

it amounts to only 50 per cent. of the top-floor load, no further deductions are to be made. The loads on the remaining floors are to be taken at a uniform figure of 50 per cent. of the top-floor load. The load on the foundations is the sum of all the loads thus calculated, plus the dead load due to the weight of the structure. The load on pillars at any level is, of course, the sum of the loads on the floors above, together with the weight of the structure above this level.

TABLE I

CAST-IRON PILLARS

Ratio of Length to Least Radius of Gyration	Working Stresses, in Tons Per Square Inch of Net Section		
	Hinged Ends	One End Hinged and One End Fixed	Both Ends Fixed
20	3·5	4·0	4·5
30	3·0	3·5	4·0
40	2·5	3·0	3·5
50	2·0	2·5	3·0
60	1·5	2·0	2·5
70	1·0	1·5	2·0
80	0·5	1·0	1·5

50. Resistance to Wind Pressure.—All buildings are required to be designed so as to resist safely a wind pressure in any horizontal direction of not less than 30 pounds per square foot, measured over the upper two-thirds of the surface exposed to wind pressure.

51. Allowable Stresses on Pillars.—The Act contains tables giving the allowable stresses, in tons per square inch of section, on iron and steel pillars. These stresses vary in

TABLE II

MILD-STEEL PILLARS

Ratio of Length to Least Radius of Gyration	Working Stresses, in Tons Per Square Inch of Section		
	Hinged Ends	One End Hinged and One End Fixed	Both Ends Fixed
20	4·0	5·0	6·0
40	3·5	4·5	5·5
60	3·0	4·0	5·0
80	2·5	3·5	4·5
100	2·0	3·0	4·0
120	1·0	2·5	3·5
140	0·0	2·0	3·0
160		1·0	2·5
180		0·0	1·5
200			0·5
210			0·0

accordance with the ratio of the length of a pillar to a property of the section termed the least radius of gyration. The allowable stresses are given in Tables I and II.

52. The working stresses on wrought-iron pillars are stated to be not more than two-thirds the working stresses specified for steel pillars. Wrought iron is, however, now hardly ever used for columns or stanchions. In all pillars it is allowable to adopt proportionate stresses for ratios between the round numbers given in the first columns of Tables I and II. Working stresses exceeding those specified to the extent of 25 per cent. are allowed in cases in which the excess of stress is due to the action of wind pressure.

TABLE III

IRON AND STEEL

Material	Working Stresses, in Tons Per Square Inch			
	Tension	Compression	Shearing	Bearing
Cast iron . .	1·5	8·0	1·5	10
Wrought iron	5·0	5·0	4·0	7
Mild steel . .	7·5	7·5	5·5	11

When a pillar is eccentrically loaded, that is, when the centre of gravity of the load does not coincide in position with the line of the longitudinal axis of the pillar, the stress due to the eccentricity of the load is required to be calculated and added to the stress due to the load when considered as an axial load. The combined stresses thus obtained must not exceed the working stress based on the ratio of the length of the pillar to the least radius of gyration of its section.

TABLE IV

ALLOWABLE PRESSURES ON SOILS

Character of Soil	Tons Per Square Foot
Natural bed of soft clay, or wet or loose sand	1
Natural bed of ordinary clay, or confined sand	2
Natural bed of compact gravel, London blue clay, or chalk . .	4

53. **Allowable Stresses on Iron and Steel.**—The Act specifies the working stresses allowable in the case of iron and steel when

used otherwise than for pillars. These stresses are given in Table III, and are well worth committing to memory.

54. Bearing Resistance of Soils and Building Materials.—The maximum allowable pressure on foundation soils and on the materials used in walling are specified in the Act. The allowable safe bearing pressure on the soils met with in London are given in Table IV. The pressures allowed are based on somewhat conservative practice. Some authorities would allow greater pressures. The allowable safe bearing pressures on brickwork of the several kinds met with in London work are given in Table V. These figures approximately coincide with general practice. The maximum allowable pressure on concrete is stated to be 12 tons per square foot.

TABLE V

ALLOWABLE PRESSURES ON BRICKWORK

Material	Tons Per Square Foot
Blue brick in cement mortar	12
Hard brick, including London stock, in cement mortar	8
Ordinary brick in cement mortar	5

55. Alterations to Buildings. — The Act provides for the carrying out of alterations or additions to buildings in steel-frame construction. The portion of the Act dealing with this subject is as follows:

> It shall be lawful to make any addition to, or alteration of, or to do other work to, in, or upon a building in accordance with the provisions of this section, provided that the loads and stresses in the part of a building so added, or altered, or to, in, or upon which such other work is done, are transmitted from the roof to the foundations by a skeleton framework of metal, or partly by a skeleton framework of metal and partly by a party wall or party walls; and the provisions of this section shall in all respects apply to such part of a building as if the same were a separate building.

REINFORCED-CONCRETE CONSTRUCTION

56. In Section 23 the County Council are given power to make regulations with regard to the construction of buildings that are wholly or partly of reinforced concrete. Before any

such regulations have effect they must be allowed by the Local Government Board, and before applying to the Board to allow any such regulations the Council are required to give notice to the following professional bodies: The Surveyors' Institution, the Institution of Civil Engineers, the Royal Institute of British Architects, and the Concrete Institute. If any one of these societies consider some of the regulations to be undesirable, they can then presumably place their objections before the Board. When the regulations are made and have been confirmed by the Board, copies are to be obtainable at the County Hall.

ADMINISTRATION OF ACT OF 1909

57. Authority of District Surveyor.—No provision is made in the Act of 1904 as to the administration of the regulations for reinforced-concrete construction. This matter will presumably be dealt with in the regulations themselves. The administration of detailed requirements as to steel-frame construction contained in Section 22 is in the hands of the district surveyors. It is provided that when any work of this description is proposed, the notice required to be served on the district surveyor under Section 145 of the Building Act of 1894 must be accompanied by plans and sections of sufficient detail to show the construction, together with a copy of the calculations of the loads and stresses to be provided for, and particulars of the materials to be used.

58. Requirements by District Surveyor.—Should the district surveyor consider that the plans and particulars furnished him are not in sufficient detail, he may require further plans and particulars. The district surveyor, when supervising the construction of a building erected under the Act, may require to be furnished with reasonable proof as to the quality of the metal to be used, and, if necessary, he may order tests to be made. Any person dissatisfied with any requirement of a district surveyor may, within 14 days of the date of the service of the notice of such requirement, appeal to the police court of the district, and the court will then make an order affirming the requirement or otherwise.

59. Applications to County Council.—The Act provides that in a list of specified cases the Council have a right, on application being made to them, to modify or waive the requirements that apply to such cases. The principal requirements subject to this right are those affecting the encasing of the metal work, the construction of girders, the thickness of walls, the painting of metal work, the allowance to be made for wind pressure, and the allowable pressures on soils. In the event of the Council refusing to modify or waive a requirement, or in the event of the Council consenting subject to conditions, any person who is dissatisfied with the refusal or with the imposition of conditions may apply to the Tribunal of Appeal. It should be noted that the Tribunal of Appeal, who, when dealing with ordinary cases, consist of three members, are strengthened, when deciding cases under the Act, by the inclusion of a fourth member, appointed by the Institution of Civil Engineers.

60. Increased Fees to District Surveyors.—The Act provides that where, under the provisions of Part IV of the Act, or of any regulations in force thereunder, any building is erected or any addition or alteration or other work is carried out, the district surveyor is to be paid $2\frac{1}{2}$ times the amount of the fee specified with regard to new buildings in the Building Act of 1894. The fee is to be calculated as follows: New buildings, on the area and height, in the same manner as buildings erected under the Act of 1894; additions, on the area and height of the addition, including such portion of the building as may be structurally affected by any alteration or other work necessitated by the making of the addition; alterations, on the area and height of the portion of the building structurally affected by the alteration or other work. The rule of multiplying the ordinary fee by $2\frac{1}{2}$ applies to all buildings irrespective of their character.

The Act further provides that one-fifth the amount of any fee payable must be paid to the district surveyor at the time when the ordinary building notice is served on him under the Act of 1894. Thus, if the proposed erection of a steel-frame building is abandoned, the district surveyor will have had some remuneration for his trouble in checking the construction.

BUILDING AND DRAINAGE BY-LAWS

BUILDING BY-LAWS

BY-LAWS UNDER METROPOLIS MANAGEMENT ACT, 1878

61. City By-Laws. — None of the ordinary building and drainage by-laws apply in the City. In that area there are no building by-laws, but there are special drainage and sanitary by-laws and regulations that are administered by the City Corporation. Copies of such regulations and by-laws may be obtained at the Guildhall.

62. By-Laws as to Sites and Foundations.—The by-laws made under the Metropolis Management and Building Acts Amendment Act, 1878, deal, in the first instance, with the sites and foundations of buildings. The requirements of the by-laws in such matters are as follows:

No house, building, or other erection shall be erected upon any site or portion of any site which shall have been filled up or covered with any material impregnated or mixed with any fæcal, animal, or vegetable matter, or which shall have been filled up or covered with dust, or slop, or other refuse, or in or upon which any such matter or refuse shall have been deposited, unless and until such matter or refuse shall have been properly removed, by excavation or otherwise, from such site. Any holes caused by such excavation must, if not used for a basement or cellar, be filled in with hard brick or dry rubbish, or concrete, or other suitable material to be approved by the district surveyor.

The site of every house or building shall be covered with a layer of good concrete, at least 6 inches thick, and smoothed on the upper surface.

The foundations of the walls of every house or building shall be formed of a bed of good concrete, not less than 9 inches thick, and projecting at least 4 inches on each side of the lowest course of footings of such walls. If the site be upon a natural bed of gravel, concrete may be omitted from the foundations of the walls, with the approval of the district surveyor.

The concrete must be composed of clean gravel, broken hard brick, properly burnt ballast, or other hard material to be approved by the

district surveyor, well mixed with freshly burnt lime or cement in the proportions of 1 of lime to 6, and 1 of cement to 8 of the other material.

63. Materials for Walling.—The by-laws provide that the external walls of every building must be constructed of good, hard, sound, well-burnt bricks or of stone or concrete. Similar bricks must be used in the portions of party and cross-walls below the surface of the ground and above the roof, including the chimney stacks. In the remaining portions of party and cross-walls, bricks of an inferior quality may be used. All brick and stone work must be put together with good mortar or cement. Lime mortar must be mixed in the proportions of 1 part of lime to 3 parts of sand. **Burnt ballast,** a material formed by burning lumps of clay, may be substituted for the sand if the ballast is properly mixed with the lime in a mortar mill. Cement mortar is to be mixed in the proportions of 1 part of cement to 4 parts of sand.

64. Every wall of a house or building must have a damp-proof course, composed of materials impervious to moisture, approved by the district surveyor. Such course must extend through the whole thickness of the wall at a level of not less than 6 inches below the level of the lowest floor. Every external wall or enclosing wall of habitable rooms or of cellars in connection therewith which abuts against the earth must be protected by materials impervious to moisture to the satisfaction of the district surveyor. The top of every party wall and parapet wall must be finished with a course of hard well-burnt bricks set on edge in cement, or by some other efficient form of coping. When concrete is used in the construction of walls, it must be mixed in accordance with the following rules:

Whenever concrete is used in the construction of walls, the concrete shall be composed of Portland cement and of clean Thames or pit ballast, or gravel, or broken brick and stone, or furnace clinkers, with clean sand in the following proportions, namely, 1 part of Portland cement, 2 parts of clean sand, and 3 parts of the coarse material, which is to be broken up sufficiently small to pass through a 2-inch ring.

65. Supervision by District Surveyor.—The district surveyor is required to see that the by-laws are duly observed, and is to

be paid a fee of 5s. in respect of the erection of each building. On notice being given to a district surveyor of the intended erection, re-erection, alteration of or addition to a public building, it is the duty of the person giving notice to deposit plans and sections with the district surveyor. Such plans and sections must be in sufficient detail to show the construction. On notice being given to the district surveyor of the intended erection of a building of any other type or of the proposed carrying out of any works to a building of this class, he may by notice require plans to be produced for his inspection. It is a general custom to show the plans of a building to the district surveyor before any works are commenced, and consequently district surveyors have rarely to put in force their powers of serving a notice requiring the production of plans.

66. Dispensation of By-Laws.—The by-laws provide that, in any case in which the Council think it expedient, the Council may dispense with the observance of any one of the by-laws made under the Act of 1878, on such terms and conditions as they may think proper.

BY-LAWS UNDER THE LONDON COUNTY COUNCIL (GENERAL POWERS) ACT, 1890

67. By-Laws as to Plastering.—The by-laws made under the London County Council (General Powers) Act, 1890, deal principally with the question of the materials used in plastering. The requirements are as follows :

All laths used for plastering shall be sound laths free from sap, but iron or other incombustible laths, wire netting, or other suitable material to the satisfaction of the district surveyor may be used. Plastering or coarse stuff shall be composed of lime and sand in the proportion of 1 of lime to 3 of sand, mixed with water and hair; but Portland cement, Keene's cement, Parian cement, Martin's cement, Selenitic cement, or other approved cement or plaster of Paris, may also be used for plastering. The lime to be used must be freshly burnt lime. The sand to be used must be clean, sharp sand, free from loam or earthy matter. The hair to be used must be good and sound, and free from grease or dirt; 1 pound of hair to be used to every 3 cubic feet of coarse stuff. Fibrous material to the satisfaction of the district surveyor may be used instead of hair, and ground brick or furnace slag to the satisfaction of the district surveyor may be used instead of sand.

The setting coat shall be composed of lime or cement mixed with clean, washed sand, or of cement only. Clear water only is to be used in mixing the material. The Portland cement to be used must weigh not less than 90 pounds to the imperial bushel. Fibrous slab or other slab plastering of sufficient thickness, and securely fixed, may be used on ceilings, partitions, and walls to the satisfaction of the district surveyor.

In some respects, such as giving the weight of cement, in pounds per bushel, the rules are not in accordance with modern ideas, but in general they may be taken to represent good current practice. It will be noted that many matters of detail are left to the discretion of the district surveyor.

68. Minor Requirements Under the Act.—The by-laws, in addition to dealing with plastering, extend the provisions of the by-laws made under the Metropolis Management and Building Acts Amendment Act, 1878, regarding the materials used in filling in an excavated site of a building, so as to include a space of 3 feet all round the site. A fee of 5s. is required to be paid to the district surveyor in respect of his supervision of any work affected by the by-laws made under the Act of 1890.

BY-LAWS AS TO DRAINAGE AND SANITATION

BY-LAWS DEALING WITH SUBMISSION OF DRAINAGE PLANS

69. Deposit of Plans and Sections.—Although in the erection of ordinary buildings in London it is sufficient merely to give the district surveyor the opportunity of inspecting the plans that show the general construction, it is necessary, in the matter of the drainage work, to deposit plans, illustrating the arrangement proposed, with the local borough council. By-laws made under the Metropolis Management Acts Amendment (By-Laws) Act, 1899, deal very fully with this question of the submission of drainage plans to the borough council. In the City of London, plans of drainage work must be submitted to the City Corporation.

70. Requirements as to Deposit of Plans.—The by-laws require that any person who is about to carry out the construction of

a drainage system must deposit in duplicate with the borough council such plans, sections, and particulars of the proposed construction as may be necessary to enable such authority to ascertain whether the construction is in accordance with the Acts and by-laws relating to drainage work. In the preparation of the plans, the scale, except in the case of block plans, must not be less than 16 feet to 1 inch. The plans are required to show every floor served by the drainage system, and the size and position of every drain, manhole, gully, soil pipe, waste pipe, ventilating pipe, and rain-water pipe, together with the position of each sanitary fitting. The person preparing the plans is also required to show the position of all windows and other openings, and the height and position of all chimneys belonging to the building, within a distance of 20 feet from the open end of a soil pipe or ventilating pipe.

A block plan in duplicate, showing the situation of the building, and a description, also in duplicate, of the method of construction of the work, are required to be deposited with the borough council. The plans, sections, and particulars are required to be deposited at least 15 days before the work is proposed to be commenced, and, in the case of the erection of a building, before such erection is commenced.

71. Additions or Alterations to Drainage Work.—Where the work consists of additions or alterations to an existing drainage system, the person in charge of the work is required to deposit in duplicate only such plans, sections, and particulars as may be necessary to enable the authority to ascertain whether the work proposed to be executed is in accordance with the Acts and by-laws relating to drainage. If plans and sections of the existing work were submitted at the time of its construction, it will be necessary to show on the plans and sections to be deposited only so much of the existing work as will enable the relative positions of the new and existing work to be understood ; but the date of the deposit of the original plans must be quoted for the purposes of reference.

72. Use of Drainage Forms. Many borough councils have special forms for the giving of the required notice for drainage

work. Copies of these may be obtained at their offices. Blank spaces are provided on the forms for the particulars required, which are usually of a less detailed character than those specified to be furnished by the by-laws. There is also generally a space left for the drawing of the plans and sections required. It is often, however, more convenient to make these on tracing cloth and attach them to the forms.

BY-LAWS DEALING WITH DRAINS AND SOIL PIPES

73. Subsoil and Surface-Water Drainage.—The by-laws dealing with the arrangement and construction of drains and soil pipes are made under the Metropolis Management Act, 1855. They deal in the first place with the drainage of subsoil and surface water. It is provided that when the subsoil of the site of a new building is drained by means of a drain communicating with a sewer, the subsoil drain must not connect directly with the sewer, but a trap must be provided near the point of junction. Such trap must have a ventilating opening, placed on the drain side of the trap, and communicating directly with the open air. The portion of the subsoil drain between the trap and the sewer must be constructed in the manner prescribed for a soil drain.

74. Where any area, forecourt, or paved or unpaved surface in connection with a building is drained by means of a drain communicating with a sewer, all surface-water inlets to such drain must be constructed as properly trapped gullies. The drain must be constructed in the manner prescribed for a soil drain. Rain-water pipes are required to discharge in the open air over a trapped gully or into a gully above the level of the water seal of the trap. They must not be constructed so as to receive any solid or liquid matter from any water-closet, urinal, slop, or other sink or lavatory.

75. Materials for, and Sizes of, Drains.—All drains, except those used for subsoil drainage, which may be of earthenware, are required to be constructed of good sound pipes formed of glazed stoneware or cast iron, or some other equally suitable material. Every drain is to be of adequate size, and must in no

case have an internal diameter of less than 4 inches. All concrete used in connection with drainage work is required to be composed of clean gravel, or of hard brick broken up into small particles, or of suitable ballast, well mixed with clean sand and good Portland cement in the proportions of 1 part of cement, 2 parts of sand, and 6 parts of the other material.

76. Position and Construction of Drains.—A drain is not to pass under a building except where any other mode of construction is impracticable. All drains situated outside a building are required to be laid on a bed of good concrete not less than

TABLE VI

DIMENSIONS AND OTHER PROPERTIES OF DRAIN PIPES

Cast-Iron Drain Pipes			Stoneware Drain Pipes			
Internal Diameter	Minimum Thickness of Metal	Minimum Weight Per 9-Foot Length, Including Socket and Beaded Spigot or Flanges, the Socket not to be Less Than $\frac{3}{8}$ Inch Thick	Internal Diameter	Minimum Thickness of Pipe	Minimum Depth of Socket	Minimum Annular Space for the Cement
Inches	Inch	Pounds	Inches	Inch	Inches	Inch
3	$\frac{5}{16}$	110	3	$\frac{1}{2}$	$1\frac{1}{2}$	$\frac{5}{16}$
4	$\frac{3}{8}$	160	4	$\frac{5}{8}$	$1\frac{3}{4}$	$\frac{5}{16}$
5	$\frac{3}{8}$	190	5	$\frac{5}{8}$	2	$\frac{5}{16}$
6	$\frac{3}{8}$	230	6	$\frac{5}{8}$	2	$\frac{5}{16}$
			9	$\frac{3}{4}$	2	$\frac{7}{16}$

6 inches thick and projecting on each side to an extent equal to the external diameter of the drain. The concrete is, in addition, to be carried up so that the drain is embedded to the extent of not less than half its diameter. Stoneware drains are required to be jointed in cement. Cast-iron drains, if formed with socket joints, are to be jointed with caulked lead. The depth of the lead joint is in such case to be not less than $2\frac{1}{2}$ inches, and the width of the annular space for the lead not less than $\frac{1}{4}$ inch in the case of 3-inch and 4-inch pipes, and not less than $\frac{3}{8}$ inch in the case of 5-inch and 6-inch pipes. If the pipes are jointed with flange joints, a suitable insertion is to be provided and the joints are to be securely bolted together. Every drain

is to be so constructed as to be water-tight and capable of resisting a pressure of at least a 2-foot head of water. In the laying of drains no right-angled junctions are allowed, but every branch joining a main drain is to join it obliquely in the direction of the flow.

77. Standard Iron and Stoneware Drain Pipes.—The by-laws contain tables giving stated requirements to which all drain pipes must comply. The requirements relating to cast-iron and stoneware drain pipes are given in Table VI, particulars given in two tables in the by-laws being here combined in one table for convenience. It will be seen that, in the first instance, standard thicknesses and weights are given ; and that, in the second instance, the detailed points of construction affected by the requirements are the thickness of pipe, depth of socket, and width of annular space for cement.

78. Drains Under Buildings.—Where a drain, other than one for the drainage of the subsoil of the site, passes under a building, the part underneath the building is to be laid, where practicable, in a direct line, and must be completely embedded in, and covered with, good solid concrete at least 6 inches thick all round. Where, however, a drain in this position is constructed of cast iron, the pipes need not be encased in concrete, but may be merely bedded on concrete in a similar manner to a drain outside a building, or if carried above the ground may be carried on piers of iron, stone, brick, or cement concrete placed at least at every joint.

In every case where a drain passes beneath a wall, the part beneath the wall must be protected by means of an arch, flagstone, or other support arranged so as not to bear on the drain.

79. Provision of Traps. — All inlets to drains, other than inlets for the purposes of ventilation, are required to be trapped. In the case of a water-closet the trap, of course, occurs in the apparatus itself, and there is no trap at the junction with the drain. A proper intercepting trap has necessarily to be provided near the junction of a drain with the sewer. Such trap must be placed as far as possible from the building and as near

as possible to the point where the drain joins the sewer. Means of access must be provided to such trap for cleaning purposes.

80. Ventilation of Drains.—Every drainage system is required to be ventilated by means of two untrapped openings, one to serve as an inlet for fresh air and the other as an outlet for foul air. In all ordinary cases, the fresh-air inlet must be situated as near as practicable to the intercepting trap, and the foul-air outlet pipe as far as possible from the inlet pipe; but in any case where this arrangement of the ventilating openings is impracticable or undesirable, the position of the pipes may be reversed, the foul-air outlet pipe being provided near the intercepting trap and the fresh-air inlet pipe at the head of the drain. Every opening to a ventilating pipe is to be fitted with a suitable grating or cover. Bends or angles are not to be made in pipes used for drain ventilation except where unavoidable.

81. Diameter of Ventilating Pipes.—Ventilating pipes are to be constructed of the same weight and material as soil pipes. The minimum internal diameter is specified to be 4 inches. It is, however, specially provided that the soil pipe of a water-closet or the waste pipe of a slop sink may be carried up to form a ventilating pipe. In such case, the internal diameter of the pipe need not be more than $3\frac{1}{2}$ inches for a 4-inch drain.

82. Material and Construction of Waste Pipes.—The material specified for waste pipes from lavatories and ordinary sinks is lead, iron, or stoneware, but the last-mentioned material is practically never adopted. Such wastes are required to be trapped beneath the apparatus to which they are fixed. They must discharge in the open air either over a properly trapped gully, or into a gully above the level of the water seal, or into a channel leading to a gully.

83. Material and Construction of Soil Pipes.—It is permissible to form soil pipes either of lead or of cast iron. Wherever practicable, a soil pipe must be placed outside a building. In any case where it is necessary to run a soil pipe inside a building, the pipe must be constructed of drawn lead with proper wiped plumber's

joints. This is sometimes considered to be an undesirable requirement, as a lead pipe is more liable to become accidentally pierced than a heavy cast-iron pipe. Where a soil pipe is of cast iron, if, as is usual, socket joints are used, the joints are not to be less than $2\frac{1}{2}$ inches in depth, while the width for the annular space for the lead in the case of $3\frac{1}{2}$-inch and 4-inch pipes must not be less than $\frac{1}{4}$ inch, and in the case of 5-inch and 6-inch pipes not less than $\frac{3}{8}$ inch. If flange joints are used, a suitable insertion must be provided, and the pipes be securely bolted together.

84. A soil pipe must not be connected with any rain-water pipe, or with the waste of any bath or of any sink other than a slop sink. No soil pipe may have an internal diameter of less

TABLE VII

LEAD AND IRON SOIL PIPES

Diameter	Lead	Iron	
	Minimum Weight Per 10-Foot Length	Minimum Thickness of Metal	Minimum Weight Per 6-Foot Length, Including Socket and Beaded Spigot or Flanges, the Socket not to be Less Than $\frac{1}{4}$ Inch Thick
Inches	Pounds	Inch	Pounds
$3\frac{1}{2}$	65	$\frac{3}{16}$	48
4	74	$\frac{3}{16}$	54
5	92	$\frac{1}{4}$	69
6	110	$\frac{1}{4}$	84

than $3\frac{1}{2}$ inches. Every soil pipe must be carried up without diminution of its diameter, and, except where unavoidable, without any bend or angle being formed in the pipe, to such a height and in such a position as to afford, by means of the open end of such soil pipe, a safe outlet for foul air.

85. **Standard Lead and Iron Soil Pipes.**—The by-laws contain a table giving the specified weight in the case of lead pipes, and both thickness and weight in the case of iron pipes, to which all soil pipes must comply. These requirements of the by-laws are quoted in Table VII.

86. **Formation of Connections.**—The by-laws specify in detail the methods of forming the joints between pipes of different

materials. The requirements, which should be studied as illustrating good sound practice, deal with the connection of (*a*) lead pipe to iron pipe, (*b*) stoneware trap to lead pipe, (*c*) lead pipe to stoneware pipe, (*d*) iron pipe to stoneware pipe, (*e*) stoneware trap to iron pipe, and are as follows:

Any person who shall connect a lead soil pipe, waste pipe, ventilating pipe, or trap with an iron pipe or drain communicating with a sewer shall insert between such lead soil pipe, waste pipe, ventilating pipe, or trap, and such iron pipe or drain, a flanged thimble of copper, brass, or other suitable alloy, and shall connect such lead soil pipe, waste pipe, ventilating pipe, or trap with such thimble by means of a wiped or overcast metallic joint, and shall connect such thimble with such iron pipe or drain by means of a joint made with molten lead, properly caulked.

Any person who shall connect a stoneware or semi-vitrified ware trap or pipe with a lead soil pipe, waste pipe, or trap communicating with a sewer shall insert between such stoneware or semi-vitrified ware trap or pipe and such lead soil pipe, waste pipe, or trap a socket of copper, brass, or other suitable alloy, and shall insert such stoneware or semi-vitrified ware trap or pipe into such socket, making the joint with Portland cement, and shall connect such socket with the lead soil pipe, waste pipe, or trap by means of a wiped or overcast metallic joint.

Any person who shall connect a lead soil pipe, waste pipe, ventilating pipe, or trap with a stoneware or semi-vitrified ware pipe or drain communicating with a sewer shall insert between such lead soil pipe, waste pipe, ventilating pipe, or trap and such stoneware or semi-vitrified ware pipe or drain a flanged thimble of copper, brass, or other suitable alloy, and shall connect such lead soil pipe, waste pipe, ventilating pipe, or trap with such thimble by means of a wiped or overcast metallic joint, and shall insert the flanged end of such thimble into a socket on such stoneware or semi-vitrified ware pipe or drain, making the joint with Portland cement.

Any person who shall connect an iron soil pipe, waste pipe, ventilating pipe, or trap with a stoneware or semi-vitrified ware pipe or drain communicating with a sewer shall insert the beaded spigot end of such iron soil pipe, waste pipe, ventilating pipe, or trap into a socket on such stoneware or semi-vitrified ware pipe or drain, making the joint with Portland cement.

Any person who shall connect a stoneware or semi-vitrified ware trap or pipe with an iron soil pipe, waste pipe, trap, or drain communicating with a sewer shall insert such stoneware or semi-vitrified ware trap or pipe into a socket on such iron soil pipe, waste pipe, trap, or drain, making the joint with Portland cement.

At the end of each of the five forms of connection quoted there is a clause in the full text of the by-laws to the effect that it will

be sufficient if the connection is made in an equally suitable and efficient manner to that specified.

87. **Ventilation of Trap of Soil Pipe.**—The by-laws also contain requirements in reference to the ventilation of the traps of water-closets, or, in other words, to the provision of antisiphonage pipes in connection with water-closets, when such closets are used in conjunction with one another. The text of the requirements dealing with this matter is as follows:

Any person who shall construct any water-closet, the soil pipe of which shall communicate with any sewer and shall be in connection with any other water-closet, shall cause the trap of every such water-closet to be ventilated into the open air at a point as high as the top of the soil pipe, or into the soil pipe at a point above the highest water-closet connected with such soil pipe, and so that the ventilating pipe shall have in all parts an internal diameter of not less than 2 inches and shall be connected with the arm of the soil pipe or the trap at a point not less than 3 and not more than 12 inches from the highest part of the trap and on that side of the water seal which is nearest to the soil pipe. He shall cause the joint between the ventilating pipe and the arm of the soil pipe or the trap to be made in the direction of the flow.

He shall construct such ventilating pipe in drawn lead or of heavy cast iron. Provided that in any case where it shall be necessary to construct such ventilating pipe within a building he shall construct such ventilating pipe in drawn lead.

He shall construct such ventilating pipe, whether inside or outside a building, so that if the pipe be of lead its weight shall not be less than 45 pounds per 12-foot length, and if the pipe be of iron its thickness shall not be less than $\frac{3}{16}$ inch and its weight not less than 25 pounds per 6-foot length.

He shall in all cases cause the joints in and the connections to such ventilating pipe to be made in the same manner as if such ventilating pipe were a soil pipe.

88. **Arrangement of Slop Sinks and Urinals.**—It is provided in the by-laws that slop sinks and urinals must be trapped, furnished with antisiphonage pipes, and in other respects treated in a similar manner to water-closets, with the exception that the waste pipe to such an apparatus need not have an internal diameter of more than 3 inches. If such pipe is constructed of lead, it must have a weight of at least 60 pounds per 10-foot length; if of cast-iron, the minimum weight is 40 pounds per 6-foot length.

89. Application to Existing Buildings.—The by-laws are stated to apply, so far as practicable, to the construction or reconstruction of any pipe or drain, or any apparatus connected therewith in an existing building, just as if the same were being constructed in a new building. It is evident, however, that in carrying out works of reconstruction in old buildings difficulties are often encountered in complying with the strict letter of the by-laws, but in such cases it will usually be found that the officials of the local borough council are willing to adopt a reasonable attitude in the enforcement of the requirements.

BY-LAWS DEALING WITH WATER-CLOSETS AND OTHER SANITARY ARRANGEMENTS

90. Position of Water-Closet or Earth-Closet.—The by-laws dealing with water-closets, earth-closets, privies, ash-pits, and cesspools are contained in by-laws made under the Public Health (London) Act, 1891. The first of this set of by-laws deals at the outset with the position of water-closets and earth-closets. The requirements are as follows:

Every person who shall hereafter construct a water-closet or earth-closet in connection with a building shall construct such water-closet or earth-closet in such a position that, in the case of a water-closet, one of its sides at the least shall be an external wall, and in the case of an earth-closet, two of its sides at the least shall be external walls, which external wall or walls shall abut immediately upon the street, or upon a yard or garden or open space of not less than 100 square feet of superficial area, measured horizontally at a point below the level of the floor of such closet. He shall not construct any such water-closet so that it is approached directly from any room used for the purpose of human habitation, or used for the manufacture, preparation, or storage of food for man, or used as a factory, workshop, or workplace, nor shall he construct any earth-closet so that it can be entered otherwise than from the external air.

91. Requirements as to Construction of Water-Closets.—Immediately following the requirements as to the position of water-closets and earth-closets are those referring to the construction of water-closets:

He shall construct such water-closet so that on any side on which it would abut on a room intended for human habitation, or used for the manufacture, preparation, or storage of food for man, or used as a factory,

workshop, or workplace, it shall be enclosed by a solid wall or partition of brick or other materials, extending the entire height from the floor to the ceiling.

He shall provide any such water-closet that is approached from the external air with a floor of hard, smooth, impervious material, having a fall to the door of such water-closet of $\frac{1}{2}$ inch to the foot.

He shall provide such water-closet with proper doors and fastenings.

92. Requirements as to Basement Water-Closets.—It is, however, specially provided that water-closets constructed below the level of the ground and approached directly from an open space of specified area need not comply with the requirements quoted in Arts. **90** and **91**. The text of this special requirement is as follows :

Provided always that this by-law shall not apply to any water-closet constructed below the surface of the ground and approached directly from an area or other open space available for purposes of ventilation, measuring at least 40 superficial feet in extent, and having a distance across of not less than 5 feet, and not covered in otherwise than by a grating or railing.

It should be specially noted that the exemption from the ordinary requirements only applies when the water-closet is approached directly from the external air.

93. Ventilation of Water-Closets and Earth-Closets.—Every water-closet, whether or not constructed within a building, and every earth-closet must be furnished with a window of such dimensions that an area of not less than 2 square feet, which may be the whole or a part of the window, shall open into the external air. In addition, the water-closet or earth-closet is to be provided with means of constant ventilation by at least one air brick built in an external wall, or by an air shaft or other effectual contrivance.

94. Apparatus of Water-Closet.—The cistern for supplying the water flush for a water-closet must be distinct from any cistern used for drinking purposes. The flush pipe must have an internal diameter of not less than $1\frac{1}{4}$ inches. The pan of the closet must be constructed so that the excreta will fall free of the sides and directly into the water contained in the pan. There are several other requirements, all dealing with the detailed construction

of the apparatus. Generally speaking, however, it may be said that a person who provides fittings of a good sound character will not have much occasion to trouble about the requirements of the by-laws, for the standard of his work will be above that specified in the by-laws.

95. Reconstruction of Existing Apparatus.—The by-laws deal with the question of alterations to or the reconstruction of an existing apparatus as follows :

A person who shall newly fit or fix any apparatus in connection with any existing water-closet shall, as regards such apparatus and its connection with any soil pipe or drain, comply with such of the requirements of the foregoing by-laws as would be applicable to the apparatus so fitted or fixed if the water-closet were being newly constructed.

96. Apparatus of Earth-Closet.—Every earth-closet is required to be constructed for use in combination with a movable receptacle for excreta. The capacity of this receptacle must not exceed 2 cubic feet. A suitable receptacle of adequate capacity for dry earth must also be provided. The earth-closet must be so constructed that the contents of either receptacle are not exposed to rainfall or to the drainage of any waste water.

97. Situation and Construction of Privies.—A privy must be distant at least 20 feet from a dwelling house or public building, or any building in which any person may be, or may be intended to be, employed in any manufacture, trade, or business. A privy must also be distant at least 100 feet from any well, spring, or stream of water used for drinking or domestic purposes. The question of means of access to privies is dealt with as follows :

Every person who shall construct a privy in connection with a building shall construct such privy in such a manner and in such a position as to afford ready means of access to such privy, for the purpose of cleansing such privy and of removing filth therefrom, and in such a manner and in such a position as to admit of all filth being removed from such privy, and from the premises to which such privy may belong, without being carried through any dwelling house or public building, or any building in which any person may be, or may be intended to be, employed in any manufacture, trade, or business.

Every privy must be ventilated, and the floor must be paved with non-absorbent material having a fall of $\frac{1}{2}$ inch to a foot.

The receptacle for excreta must be movable and not exceed 2 cubic feet in capacity. The remaining requirements relate to the detailed construction of the floor and of the wooden framing on which the seat is usually supported.

98. Construction of Ash-pits. — The construction of fixed ash-pits in ordinary buildings is not permitted by the by-laws. It is required that one or more movable receptacles constructed of metal, with suitable handles and cover, shall be provided, and that the capacity of such receptacle shall not exceed 2 cubic feet. Where, however, an ash-pit is constructed in connection with premises in which one of the conditions of tenancy confers a right to the disposal of refuse in an ash-pit used in common by several tenants, the ordinary requirements do not apply; but the ash-pit provided in such a case must not be of greater capacity than that which will enable it to contain the refuse that may accumulate during a maximum period of 1 week.

99. Situation and Construction of Cesspools.—A cesspool must be situated at least 100 feet from a dwelling house or public building, or any building in which any person may be, or may be intended to be, employed in any manufacture, trade, or business. A cesspool must be a similar distance from any well, spring, or stream of water. The requirements as to the means of access to be provided to a cesspool are very similar to those quoted in Art. **97** with regard to privies. It is provided that no cesspool is to have any means of communication with a sewer.

The general rules relating to the construction of a cesspool are as follows:

> Every person who shall construct a cesspool in connection with a building shall construct such cesspool of good brickwork bedded and grouted in cement, properly rendered inside with cement, and with a backing of at least 9 inches of well-puddled clay around and beneath such brickwork, and so that such cesspool shall be perfectly water-tight. He shall also cause such cesspool to be arched or otherwise properly covered over, and to be provided with adequate means of ventilation.

The by-laws conclude with references to the construction and position of receptacles for dung. As these requirements only affect stable premises, they are not quoted here.

MISCELLANEOUS REQUIREMENTS

REGULATIONS OF LONDON COUNTY COUNCIL

SCOPE OF REGULATIONS

100. Regulations as to Applications.—In addition to the by-laws, there are several sets of regulations issued by the County Council, copies of which may be obtained at the County Hall. Some of the most frequently consulted regulations are those dealing with applications to the Council under the Building Acts and the preparation of the plans to accompany such applications. These regulations provide that all drawings must be submitted in duplicate, and that the drawings must either be made on the unglazed side of tracing linen or consist of reproductions on white linen. The scale for the drawings is specified, and varies in accordance with the subject with regard to which application is made. Every set of drawings must be accompanied with a block plan showing the locality, and a scale and North point must be drawn on each sheet.

101. Regulations as to Means of Escape.—Very full regulations exist with regard to the provision of means of escape in case of fire from premises coming within the scope of the escape requirements of the London Building Acts (Amendment) Act, 1905, or of the Factory and Workshop Acts, 1901 and 1907. These regulations state the particulars required to be given when an application is made for the Council's consent to means of escape. They also deal with the factors to be taken into consideration when arranging a system of means of escape. They state that it may be laid down as a general principle that at least one enclosed staircase will be required, and, in addition, an alternative means of escape from each floor by way of a second staircase, or by balconies or gangways leading to adjoining premises, or

by some other suitable arrangement of a permanent character. No arrangement which is not permanently fixed in position or which requires manipulation will be accepted.

The regulations also deal with the detailed construction of staircases, whether constructed of brick and concrete, or of hardwood, or of iron, the last-mentioned material being generally used in the case of external staircases. A copy of these regulations should be obtained and carefully studied before an attempt is made to arrange the means of escape in case of fire from any building that comes within the scope of the escape requirements.

102. Regulations as to Cubical Extent.—Special regulations have been made dealing with applications for additional cubical extent in the case of buildings coming within the scope of the provisions of Part III of the London County Council (General Powers) Act, 1908. They deal principally with the questions of size and situation as affecting the allowance by the Council of additional cubical extent.

103. Regulations as to Theatres and Music Halls.—Regulations made under the Metropolis Management and Building Acts Amendment Act, 1878, with regard to theatres and music halls and other similar places licensed for music and dancing, are still in force. The construction of such premises, and the means to be adopted to prevent the outbreak and spread of fire, and the methods of arranging entrances and exits, are dealt with very thoroughly. It may be noted that the walls of buildings of this class are required to be of similar thickness to walls of buildings of the warehouse class, or of such greater thickness as may be required by the district surveyor, or, in the event of an appeal, of the Tribunal of Appeal. The regulations also deal with the question of the street frontages of premises of this kind, one-half at least of the total length of the boundaries of the site being required to abut on public thoroughfares. It should be noted, however, that in this and other respects the Council may, at their discretion, modify or dispense with the regulations. Every person who may at any time be engaged in the design of premises of this description should obtain and carefully study a copy of the regulations.

FACTORY AND WORKSHOP ACTS, 1901 AND 1907

MEANS OF ESCAPE

104. Requirements as to Recently Erected Buildings.—All factories and workshops in which more than 40 persons are employed come within the scope of the requirements of the Factory and Workshop Act, 1901, as to means of escape. The Act of 1907 is of importance only in view of the fact that it brings laundries within the scope of the Act of 1901. The requirements vary according to whether the factory or workshop is of old construction or whether it has been erected within comparatively recent years. The text of the requirements relating to recently erected buildings, as contained in Section 14 of the Act, is as follows :

> Every factory of which the construction was not commenced on or before January 1, 1892, and in which more than 40 persons are employed, and every workshop of which the construction was not commenced before January 1, 1896, and in which more than 40 persons are employed, must be furnished with a certificate from the district council of the district in which the factory or workshop is situate that the factory or workshop is provided with such means of escape in case of fire for the persons employed therein as can reasonably be required under the circumstances of each case, and, if the factory or workshop is not so furnished, it shall be deemed not to be kept in conformity with this Act ; and it shall be the duty of the Council to examine every such factory and workshop, and, on being satisfied that the factory or workshop is so provided, to give such a certificate as aforesaid. The certificate must specify in detail the means of escape so provided.

105. Requirements as to Old Buildings.—There are different requirements having reference to factories and workshops not affected by the foregoing provisions of the section ; that is, to factories whose construction was commenced before 1892, and to workshops whose construction was commenced before 1896. The requirements provide that, as regards factories and workshops of this class in which more than 40 persons are employed, it is the duty of the district council from time to time to ascertain whether all such factories and workshops within their district are provided with satisfactory means of escape. In case

a factory or workshop is not so provided, it is the duty of the district council to serve a notice on the owner requiring him to provide such means of escape as can be reasonably required under the circumstances. The owner is then entitled, notwithstanding any agreement he may have with the occupier, to take such steps as are necessary to comply with the requirements. If the requirements of the district council are not complied with, the owner is liable to a fine for every day that the non-compliance continues. Throughout the whole of London the County Council act as the district council.

106. Owner's Right of Arbitration.—Where a difference of opinion arises between the Council and an owner of a factory or workshop of the kind referred to in Art. **105**, it is provided that the dispute shall be referred to arbitration on the application of either party, which application must be made within 1 month after the time when the dispute arises. The arbitration must be conducted in accordance with the provisions contained in the First Schedule to the Act, and the arbitration award will be binding on the parties, and either confirm, amend, or discharge the requirements of the Council.

107. Rights of Owner as to Expenses.—If an owner who has been made to carry out escape requirements considers that the occupier of the factory or workshop ought to bear or contribute to the expenses of complying with the requirements, he may apply to the county court. The Court then has the right, after hearing the occupier, to make such order as regards expenses as seems to the Court to be just and equitable.

PUBLIC HEALTH (LONDON) ACT, 1891

REQUIREMENTS AS TO UNDERGROUND ROOMS

108. Definition of Underground Room.—The Public Health (London) Act, 1891, deals with the question of **underground rooms**, and defines an underground room as one of which the surface of the floor is more than 3 feet below the surface of the

footway of the adjoining street or of the ground adjoining or nearest to the room.

109. Prohibition of Separate Occupation of Underground Rooms.—It is provided in Section 96 of the Act that no underground room, which was not let or occupied separately as a dwelling before the passing of the Act, may be so let or occupied unless it complies with the following requirements :

(*a*) Unless the room is in every part thereof at least 7 feet high, measured from the floor to the ceiling, and has at least 3 feet of its height above the surface of the street or ground adjoining or nearest to the room. Provided that, if the width of the area hereinafter mentioned is not less than the height of the room from the floor to the said surface of the street or ground, the height of the room above such surface may be less than 3 feet ; but it shall not in any case be less than 1 foot, and the width of the area need not in any case be more than 6 feet ;

(*b*) Unless every wall of the room is constructed with a proper damp-course, and, if in contact with the soil, is effectually secured against dampness from that soil ;

(*c*) Unless there is outside of and adjoining the room, and extending along the entire frontage thereof, and upwards from 6 inches below the level of the floor thereof, an open area, properly paved, at least 4 feet wide in every part thereof. Provided that in the area there may be placed steps necessary for access to the room, and over and across such area there may be steps necessary for access to any building above the underground room, if the steps in each case be so placed as not to be over or across any external window ;

(*d*) Unless the said area and the soil immediately below the room are effectually drained ;

(*e*) Unless, if the room has a hollow floor, the space beneath it is sufficiently ventilated to the outer air ;

(*f*) Unless any drain passing under the room is properly constructed of a gas-tight pipe ;

(*g*) Unless the room is effectually secured against the rising of any effluvia or exhalation ;

(*h*) Unless there is appurtenant to the room the use of a water-closet and a proper and sufficient ash-pit ;

(*i*) Unless the room is effectually ventilated ;

(*j*) Unless the room has a fireplace with a proper chimney or flue ;

(*k*) Unless the room has one or more windows opening directly into the external air with a total area, clear of the sash frames, equal to at least one-tenth of the floor area of the room, and so constructed that one-half at least of each window of the room can be opened, and the opening in each case extends to the top of the window.

110. Dispensation of Requirements. — The section provides that the requirements are to apply to underground rooms let or occupied separately as dwellings before the commencement of the Act. The local borough council, which is charged with the administration of the section, has, however, the power to modify or dispense with any of the requirements that involve the structural alteration of a building. In the City, the administrative authority is the City Corporation. A dispensation or modification may be allowed either absolutely or for a limited time. If the owner of any room is aggrieved by a dispensation or modification not being allowed, he may appeal to the Local Government Board, and the Board may refuse or wholly or partly allow the dispensation. The decision of the Board will, of course, overrule that of the local sanitary authority.

ADDITIONAL REQUIREMENTS AS TO STREETS

PROVISIONS OF METROPOLIS MANAGEMENT ACTS

111. By-Laws as to New Streets.—In addition to the requirements of the London Building Act, 1894, as to new streets, the formation and construction of streets are dealt with in the Metropolis Management Acts. By-laws as to new streets have been made under the Metropolis Management Act, 1855. The requirements contained in these by-laws are as follows :

The carriageway of every new street must curve or fall from the centre or crown thereof at the rate of $\frac{3}{8}$ inch at the least for every foot of breadth. In every new street the kerb to each footpath must not be less than 4 inches nor more than 8 inches above the channel of the roadway, except in the case of crossings, paved or formed, for the use of foot-passengers ; and the slope of every footpath toward the kerb must be $\frac{1}{2}$ inch to every foot of width if the footpath be unpaved, or not less than $\frac{1}{4}$ inch to every foot of width if the footpath be paved.

The remaining requirements of the by-laws are superseded by those of the Building Act of 1894.

112. Making Up of Private Streets.—The question of the paving, or making up as it is frequently termed, of private streets

is dealt with in Section 105 of the Metropolis Management Act, 1855. The provisions of this important section are as follows :

In case the owners of the houses forming the greater part of any new street laid out or made, or hereafter to be laid out or made, which is not paved to the satisfaction of the vestry or district board of the parish or district in which such street is situate, be desirous of having the same paved as hereinafter mentioned, or if such vestry or board deem it necessary or expedient that the same should be so paved, then and in either of such cases such vestry or board shall well and sufficiently pave the same, either throughout the whole breadth of the carriageway and footpaths thereof, or any part of such breadth, and from time to time keep such pavement in good and sufficient repair ; and the owners of the houses forming such street shall, on demand, pay to such vestry or board the amount of the estimated expenses of providing and laying such pavement, such amount to be determined by the surveyor for the time being of the vestry or board ; and in case such estimated expenses exceed the actual expenses of such paving, then the difference between such estimated expenses and such actual expenses shall be repaid by the said vestry or board to the owners of houses by whom the said sum of money has been paid ; and in case the said estimated expenses be less than the actual expenses of such paving, then the owners of the said houses shall, on demand, pay to the said vestry or board such further sum of money as, together with the sum already paid, amounts to such actual expenses.

Section 77 of the Metropolis Management Amendment Act, 1862, provides that where a street is made up the owners of land must contribute to the expenses, but they may be charged in a less proportion than the owners of house property.

113. Notice of Objection of Owners.—Section 106 of the Act of 1855, which deals with the rights of objection of owners to the carrying out of private-street works, has been for the most part repealed and replaced by Section 80 of the Act of 1862. This latter section provides that no private street shall be repaired until notice is given to the owners and rated occupiers of the houses in such street, and that no street shall be repaired at all by the local authority if, within 1 month after notice has been given, written notice of objection to such repair, signed by at least two-thirds of the owners or rated occupiers of the houses in the street, shall be given to the local authority. These provisions do not extend to the City, in which area special requirements contained in the City of London Sewers Acts apply.

PROVISIONS OF HOUSING AND TOWN PLANNING ACT, 1909

114. The requirements as to street formation in London must now be considered in connection with the provisions of the Housing and Town Planning Act, 1909. This Act provides that the local authority may formulate a town plan for any portion of their district, or may approve an arrangement of land development proposed by private owners. Before any town-planning scheme comes into force it must be confirmed by the Local Government Board. In any area in which a town-planning scheme is in force, the ordinary requirements of the law as to width of streets will be superseded by those of the scheme.

PROVINCIAL BUILDING LAW

LAWS AND BY-LAWS IN FORCE

INTRODUCTION

VARYING LOCAL REQUIREMENTS

1. Introduction.—The building law in the British Isles may be roughly divided into the law applying to the Metropolis and the law applying to districts outside the Metropolis. The requirements applying to the Metropolis are dealt with in *London Building Law*, Parts 1 and 2. The provincial building law may be divided into: (*a*) the law in England and Wales; (*b*) the law in Scotland; and (*c*) the law in Ireland. But this, however, does not mean that there is one general and inclusive set of requirements applying to each of these three divisions. The general statute law is the same throughout the whole of any one of these divisions, but many of the larger towns have local Acts; further, the majority of the building and drainage requirements are contained in by-laws. Local authorities have their own by-laws, and although these are based on a common model, they differ to a certain extent in every district. Therefore, it is possible to give only the main outlines of the provincial building law; the details will depend on the character of the local by-laws. A copy of the by-laws should always be obtained and carefully studied before commencing the preparation of plans for building or drainage work in any district. In some districts a small charge is made for a copy of the by-laws; in others, a charge

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is made only when the person applying is not a ratepayer in the district, and frequently there is no charge at all.

2. **Points to be Considered.**—In considering the possible application of the provisions of either the statute law or the local by-laws to any proposed building work, it is usually necessary to pay attention to the position of the building in relation to the street, the arrangement and detailed construction of the drains and sanitary fittings, and, in urban districts, the main points in the construction of the building itself. In all cases plans of proposed works must be submitted to the local authority. In the majority of instances, the law will require only such constructional arrangements as any competent architect will, in the interests of his client, provide ; but occasionally requirements are met with which either have no logical basis, or are based on methods of construction which are now considered obsolete. Few local authorities are vested with power definitely to waive any of the requirements of their by-laws, yet they usually exercise a certain amount of discretion in the question of administration. Thus, if any requirement in a set of local by-laws appears to be unreasonable or unnecessary in any particular case, tactful inquiries of the local official, usually the borough or district surveyor, entrusted with the administration of the by-laws, will often disclose the fact that the local council do not insist on the requirement in question in any case where its enforcement appears unnecessary.

OUTLINES OF LAW

3. **Law in England and Wales.**—The basis of the provincial building law in England and Wales is the Public Health Act, 1875. This Act contains very important provisions with regard to sewerage, drainage, and the construction of streets and buildings. Local authorities derive from this Act the power to make the principal portion of their by-laws. These, however, are of no effect until they have been confirmed by the Local Government Board, the government department which exercises a general control over local authorities in England and Wales.

The Public Health Act of 1875 has, however, been amended on several occasions, the principal amending Acts being those of 1888, 1890, and 1907. The Act of 1888 regulates the frontage of buildings in streets, while the Acts of 1890 and 1907 permit the local authorities to make more stringent by-laws than was permitted by the original Act. The making up and taking over of private streets by local authorities are regulated in the principal districts by the Private Street Works Act, 1892. This Act, however, is in force only where the local authorities have formally adopted it. In districts where this Act has not been adopted, the making up and taking over of a street are regulated by the provisions of the Public Health Act, 1875.

4. Law in Scotland. — Scotch law is admittedly a most intricate and difficult subject. The building requirements are based on the Burgh Police (Scotland) Act, 1892, and its amending Acts, and also, in a less degree, on the Public Health (Scotland) Act, 1897. There is the same diversity of building requirements as in England and Wales, for such local authorities as have adopted portions of the Burgh Police Act have pleased themselves as to what provisions of the Act they have adopted. Also, in the larger towns, many requirements are based on special powers obtained by means of local Acts. The application of the building requirements in Scotland is further complicated by the existence of rights of ownership with regard to portions of a building, which rights do not occur throughout the rest of the British Isles, where freehold ownership of a portion only of a building is almost unknown.

5. Law of the Tenement.—The branch of the common law in Scotland called the **law of the tenement** admits of a building being in several ownerships. By *common law* is meant the law which has grown up by custom and has been affirmed from time to time by decisions in courts of law, but which is not laid down in writing, like the statute law. The law of the tenement centres round two rights known as *common property* and *common interest*. These rights appear to have arisen from the practice of creating separate freeholds in the various floors of a house. On the principle of common interest, the owner of a tenement

may object to another owner carrying on any operations which are injurious to his tenement. Operations, however, which are consistent with the purpose of that part of the property operated on are not held to be injurious operations. The consent of all owners is necessary where anything is to be done which is an injury or material prejudice to the rights of the other proprietors; nor can any proprietor, without the consent of all the others, carry out any operations which would increase the obligations of the other proprietors as regards the support of his tenement. This right of common interest has a corresponding obligation or burden. Each proprietor is bound to keep his tenement in such a condition that the property of the other proprietors is not prejudiced by its condition. For instance, the proprietor of the topmost floor, who is owner of the roof, is obliged to keep the roof in repair for the benefit of the other proprietors.

6. The right of common property is subject to the right of common interest. It gives each proprietor a right to prevent injurious interference with any part of any tenement adjacent or subjacent to his own. Each proprietor has the right of carrying out all operations to his own tenement which are not injurious operations. The staircase and gangways common to the proprietors are held by them as common property. All repairs and works necessary to keep the common staircase and gangways in good condition must be carried out at the joint expense of the proprietors.

7. **Law in Ireland.**— The building law in Ireland is not very dissimilar to that in England and Wales. There are not the exceptional features met with in Scotland. The building requirements in Ireland are based on the Public Health (Ireland) Act, 1878, and its various subsequent amending Acts. There is, however, just the same diversity in the building regulations as throughout the rest of the British Isles, for the by-laws of the local authorities, though based on a common model, vary considerably. Also, many of the important towns have local Acts which contain provisions relating to the construction of buildings. Generally speaking, the building requirements in Irish districts are less stringent than those in the rest of the British Isles.

ADMINISTRATION OF LAW

8. **Administrative Authorities.**—For building purposes, there are four classes of administrative areas in England and Wales: cities, boroughs, urban districts, and rural districts. The distinction between a city and a borough is of little practical importance; each is governed by a body termed a *corporation*. Urban and rural districts are controlled by district councils. Thus, there are three classes of local administrative authorities, corporations, urban district councils, and rural district councils. There are, of course, also county councils, but these do not exercise direct control over building operations. Each local body appoint a committee to deal, either exclusively or in connection with other business, with the administration of the building law. This committee consider the plans submitted, and recommend the local authority as to the action to be taken as regards the approval or disapproval of the plans. In the larger towns the committee are sometimes authorized by the local authority to deal directly with certain matters on behalf of such authority, which results in a considerable saving of time. The official entrusted with the administration of the law is usually the local engineer and surveyor. In the larger districts he is generally termed the city or borough engineer, but in the smaller districts the term surveyor, or engineer and surveyor, is more frequently used. In large districts, the work of supervising the erection of buildings is generally carried out by building inspectors who are under the control of the local engineer; in small districts, the engineer and surveyor himself attends to this work.

9. In Scotland, the administrative areas are cities, burghs, and counties. In the burghs, the body charged with the administration of the building law are termed the Dean of Guild Court, and consents to plans are issued by the Dean of Guild, who is the head of this court. In Ireland, the administrative authorities are corporations and urban and rural district councils, as in England and Wales.

10. **Model By-Laws.**—The jurisdiction of local authorities extends not only to the work of seeing that the building law is

complied with, but also to the framing of such portions of the law as may be contained in by-laws. Some uniformity is necessarily produced by reason of the fact that the subject-matter of the by-laws is determined by statute law. It is not possible for a local authority to make by-laws in respect of any particular subject. They can make by-laws only with regard to such questions of arrangement and construction as they may have direct authority by Act of Parliament to regulate by means of by-laws. Yet, if this were the only thing tending to produce uniformity, considerable diversity of practice would often be occasioned. Even if the same results were aimed at, it is probable that, owing to differences in wording, these would rarely be attained. On the passing of the Public Health Act, 1875, this fact was recognized by the Local Government Board, who in 1877 issued a list of model by-laws for the guidance of local authorities. Practically all of the by-laws in England and Wales are based on this model code, which has been revised from time to time. Later, the Local Government Board for Ireland also issued a model set of by-laws.

11. In 1903, the Local Government Board issued a model code for use in rural districts. It was found that by-laws based on the code issued in 1877 were too stringent for districts where buildings were considerable distances apart. The Board, however, have left it entirely to the discretion of the various rural councils as to whether they will frame by-laws based on the old or on the new model, or whether they will do without by-laws altogether. Comparatively recently, the Board have issued a provisional draft of by-laws for rural districts, which, while more comprehensive than the model code issued in 1903, is less restrictive than the model by-laws issued in 1877.

STUDY OF BUILDING LAW

12. An architect is supposed to have a reasonable knowledge of those points of the law which directly concern technical questions. Although when a dispute arises a solicitor is engaged, the views of an architect who has paid close attention

to this branch of his work will have considerable weight. The main provisions of the principal building Acts are given here, but the Acts themselves and a summary of the principal cases decided by the law courts should be studied. It is not necessary to pay as close attention to the model by-laws as to the model laws, for they do not represent the by-laws of any one district. An exact knowledge of them is desirable only when they embody some useful constructional rules. In all other cases it will be sufficient to get a general idea of the model requirements that affect constructional work, so as to know what are the important points to be watched for in reading through the by-laws of any district in which it is proposed to build.

The law in Ireland does not differ from the English law to any very great extent ; but the law in Scotland occupies a position quite apart from the building law in any other portion of the British Empire. In building in any part of Scotland it will, therefore, be necessary to give very careful study to the local requirements. Further, if any legal questions arise, and if the architect is not resident in Scotland and thus not familiar with Scotch law, he should obtain the advice of a lawyer as to the course of action to be taken in overcoming the legal difficulties.

STATUTE LAW IN ENGLAND AND WALES

PUBLIC HEALTH ACT, 1875

13. Definition of Local Authority.—The definitions of the terms and expressions used in an Act are obviously of great importance, for the applicability of the provisions of the Act to any particular case will often depend on the manner in which some term is defined. One of the most important definitions in the Public Health Act of 1875, which Act will be hereafter termed, for shortness, the Act of 1875, is the definition of **local authority.** This term is defined as meaning urban sanitary authority and rural sanitary authority, but the Local Government Act of 1894 changed these names to the present terms of *urban district council* and *rural district council.* Corporations of

cities and boroughs which were included in the term urban sanitary authority are now known as *corporations*, or *city* or *borough councils*. Section 25 of the Local Government Act, 1894, provides that rural district councils are to have such powers, duties, and liabilities given to urban district councils by the Public Health Acts or any other Act, as the Local Government Board may direct. Therefore, where any requirement in an Act is said to refer to an urban sanitary authority, possibly some rural authorities have had this requirement extended to their districts by the Local Government Board. When, in a rural district, any important question is affected in this manner, inquiry should be made at the local office as to whether the local authority is in this respect invested with urban powers.

14. Definition of Owner.—Where premises let on a long lease are afterwards sublet, the question of ownership is often a matter of dispute when it carries with it an obligation to comply with some requirement of the local authority. The definition of *owner*, with which is also necessarily included that of *rack rent*, is, for the purpose of the Public Health Act, 1875, and its amending Acts, as follows :

Owner means the person for the time being receiving the rack rent of the lands or premises in connection with which the word is used, whether on his own account or as agent or trustee for any other person, or who would so receive the same if such lands or premises were let at a rack rent.

Rack rent means rent which is not less than two-thirds of the full net annual value of the property out of which the rent arises ; and the full net annual value shall be taken to be the rent at which the property might reasonably be expected to let from year to year, free from all usual tenant's rates and taxes and tithe commutation rentcharge, if any, and deducting therefrom the probable average annual cost of the repairs, insurance, and other expenses, if any, necessary to maintain the same in a state to command such rent.

15. The definitions just given should be read very carefully, for in any legal statement of this kind each word is of importance. While the definition of owner depends on that of rack rent, the most important part of this latter definition is that which has reference to the meaning of the term full net annual value. A *tithe commutation rentcharge* is a charge which is adjusted

annually according to the average price of corn, and which takes the place of the tenth part of the yearly increase from the profits of lands which was at one time payable under the name of tithe. This tithe rentcharge has in the case of many premises been redeemed. Under the Tithe Act, 1891, tithe rentcharge in England and Wales is payable by the owner of the lands on which it is charged, and not by the occupier. Any contract made by which the occupier undertakes to pay the tithe is not legally binding.

16. Definition of Street.—The next important definition in the Act of 1875 is that of *street*.

Street includes any highway, not being a turnpike road, and any public bridge, not being a county bridge, and any road, lane, footway, square, court, alley, or passage, whether a thoroughfare or not.

By including an alley or passage, this definition is very far-reaching, and the word street has legally a much wider meaning than that accepted in everyday conversation.

17. Definitions of Drain and Sewer.—The question of whether a length of pipe is a drain or a sewer becomes one of considerable importance when defects are found to exist. If the length of pipe is a drain, it must be repaired by the owner of the premises; if it is a sewer, it must be repaired by the local authority. This question has been the subject of numerous cases before the courts, but, unfortunately, the decisions have been so conflicting that it is most difficult to arrive at any general conclusion. This subject also cannot receive proper attention until the Public Health Acts Amendment Act, 1890, is thoroughly understood, for this Act contains a most important provision affecting this question of drain or sewer. According to the Act of 1875,

Drain means any drain of and used for the drainage of one building only or premises within the same curtilage, and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage, or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed.

Sewer includes sewers and drains of every description, except drains to which the word drain interpreted as aforesaid applies, and except drains vested in or under the control of any authority having the management of roads and not being a local authority under this Act.

18. Curtilage.—The term **curtilage** as used in the definition of drain is not easily explained. In ordinary cases, the word means a piece of land adjoining a dwelling house. In the present case, it may be said to refer to land within a single enclosing boundary fence or wall; but the land must be of a reasonable size. Other questions, such as those of arrangement and use, also considerably affect the decision as to whether any particular buildings are or are not premises within the same curtilage.

19. Ownership of Streets.—The portion of the Act of 1875 which principally affects the work of an architect is Part IV, which contains general provisions with regard to streets and buildings. By Section 149, all streets which become highways repairable by the inhabitants at large within any urban district are vested in and under the control of the local authority. Where **private streets,** which are repairable by their owners, are not sewered, paved, and lighted to the satisfaction of the local authority, the authority may require these to be done. Then, if no statutory objection is raised, they may declare the street to be a highway. The law governing action of this kind taken by a local authority depends on whether or not the authority have adopted the Private Street Works Act, 1892.

20. Private Streets.—The proceedings of a local authority who have not adopted the Private Street Works Act, 1892, are regulated, as regards the taking over of private streets, by Sections 150 to 152 of the Act of 1875. Section 150 provides that where a private street in an urban district is not sewered, levelled, paved, metalled, flagged, channelled, and made good, or is not lighted to the satisfaction of the local authority, such authority may by notice require the necessary works to be done. Notices must be addressed to the respective owners or occupiers of the premises fronting, adjoining, or abutting on such parts of the street as may be required to be dealt with. The term *premises* includes land as well as buildings. Before giving notice, the local authority must cause plans and sections of any structural works intended to be executed under this section, and an estimate of the probable cost, to be made by their surveyor. Such plans, sections, and estimate are to be deposited in the office of the

local authority, and are to be open for the inspection of all persons interested. If the required works are not carried out, the local authority may do the work themselves and recover the expenses from the owners of the buildings and land, according to the frontage of their respective premises. The expense is to be apportioned between the owners by the surveyor to the local authority. If any dispute arises, this is to be settled by arbitration. Where the premises abutting on a private street are in different ownerships, it is a general practice to allow any required private street works to be carried out by the local authority, the cost of the work being, of course, subsequently recovered from the owners. Section 151 provides that a church, chapel, or other place of public worship which is exempt from the poor rate, together with any churchyard or burial ground attached thereto, is not to be charged with the expense of street works. The cost of the works from which churches and chapels are exempted may be defrayed by the local authority.

21. Section 152 of the Act of 1875 provides that, when any private street has been sewered, paved, and lighted to the satisfaction of the local authority, the authority may, if they think fit, by notice in writing put up in any part of the street, declare the street to be a highway repairable out of the rates. It is provided, however, that no street shall become a highway thus repairable if, within 1 month after the notice has been put up, the proprietor, if there is only one, or the majority of the proprietors if there are more than one, objects to the street being made a highway.

22. Except in thickly populated neighbourhoods, where a big scheme of building over both houses and streets might at some time be entertained, little objection will usually be raised to the taking over of a private street by the local authority. In laying out an estate for building purposes, it is a common arrangement for the person developing the estate to construct the sewers and lay out the roads with the exception of the top finish of the carriageway portion and the paving of the footways. Then, when a fair number of houses are built on either side of the road, the local authority complete the construction of the road and charge the owners of the property on either side. Persons

buying houses or land in a partly developed street, sometimes do not realize that they will be charged with the expenses of making up the road when it is taken over by the local authority. It will be well for an architect, in such a case, to warn his client of the expense which is likely to be incurred.

23. Making and Administration of By-Laws.—Section 157 of the Act of 1875 gives the local authority power to make by-laws with regard to new streets and buildings, and specifies, in detail, the questions of arrangement and construction which may be controlled by by-laws. It was in consequence of the rights of local authorities under this section that the model by-laws were drafted by the Local Government Board. Section 158 deals with the administration of the by-laws by the local authority. It gives the local authority power to pull down any work commenced without approval, and to recover the expense of such pulling down from the person who caused the work to be executed. Sections 182 to 186 deal with the formalities to be observed in the formation of by-laws and the penalties which may be imposed when a by-law is contravened.

24. Re-erection of Projecting Building.—Section 155 of the Act of 1875 provides that when a building or front of a building in any street in an urban district is taken down in order to be rebuilt or altered, the local authority may prescribe the line to which it may be erected. Compensation is to be payable by the local authority to the owner for the loss or damage he may sustain on account of the position of the building being altered. The amount of compensation in case of dispute is to be settled by arbitration. This requirement is of chief value to local authorities in enabling them to obtain the setting back of buildings projecting in advance of the general line of buildings.

25. Re-erection of Buildings.—Section 159 of the Act of 1875 provides that, for the purpose of the Act, the re-erection of a building which has been pulled down to or below the ground floor, or of a frame building of which only the framework is left down to the ground floor, or the conversion into a dwelling house of any building not originally constructed for human habitation,

or the conversion into more than one dwelling house of a building originally constructed as one dwelling house only, is to be considered as the erection of a new building, and, as such, will come within the scope of the building law. Local authorities, however, now have power to replace this section by one in the Public Health Acts Amendment Act, 1907.

26. Dangerous Buildings.—Section 160 of the Act of 1875 incorporates several of the provisions of the Towns Improvement Clauses Act, 1847. These enable a local authority to require the removal of any projection which constitutes an obstruction to the safe and convenient passage along any street, to require the provision of hoardings during building operations, and to require the taking down or securing of dangerous buildings. Section 75 of the Towns Improvement Clauses Act provides that, if any building or wall or anything affixed thereto is deemed by the surveyor of the urban authority to be in a ruinous state or dangerous to passengers or to the occupiers of neighbouring buildings, he shall cause a hoarding to be put up for the protection of passengers, and shall by notice require the owner or occupier forthwith to take down, secure, or repair the building, wall, etc. If the necessary works are not commenced within 3 days from the service of the notice, the surveyor may lodge a complaint before two justices, who may order the owner or, in his default, the occupier to do the necessary work within a specified time and to the satisfaction of the surveyor. If the work is not done within the specified time, the local authority may do the work and recover any expenses incurred by them.

It should be noted that from the terms of the section it would appear that a building which is dangerous to its occupants only and not to passengers or to the occupiers of adjoining buildings cannot be dealt with by the local authority unless such authority have greater powers than those conferred by the Public Health Act, 1875. The law in the provinces is thus different from that in London, where a building may be dealt with if it is dangerous to any person.

27. Sanitary Accommodation for Factories.—Section 38 of the Act of 1875 provides that where a house is to be used as

a factory or building in which persons of both sexes are to be employed at one time in any manufacture, trade, or business, the local authority may require the owner or occupier of the house to construct a sufficient number of water-closets, earth-closets, or privies, and ash-pits, for the use of each sex. Where, however, Part III of the Public Health Acts Amendment Act, 1890, is adopted by the local authority, a section of such Act takes the place of Section 38 of the Act of 1875. The provision of one closet to every 20 persons is a rough rule with which it will be desirable, as far as possible, to comply.

28. Examination of Drains.—Section 41 of the Act of 1875 provides that where a local authority receive a written application stating that any drain, water-closet, earth-closet, privy, ash-pit, or cesspool of any premises within their district is a nuisance or injurious to health, the local authority may empower their surveyor or inspector of nuisances, after 24 hours' written notice to the occupier of the premises in all cases except one of emergency, to enter and, if necessary, cause the ground to be opened up and the defective drain or sanitary apparatus examined. If no defects are found, the ground is to be filled in and everything made good at the expense of the local authority. If, however, defects are found to exist, the local authority may by notice require the owner or occupier of the premises to remedy them. If this is not done a penalty will be incurred, and the local authority may, if they think fit, do the necessary work and recover expenses. This section does not appear to give local authorities power to test drains otherwise than by opening up the ground. By taking advantage of the provisions of the Public Health Acts Amendment Act, 1907, local authorities are now able to apply the smoke test.

29. Recovery of Expenses.—Expenses incurred by a local authority in carrying out works in cases of default may be recovered in a court of law or may be declared by the authority to be private improvement expenses. In such latter event a special rate, termed a *private improvement rate*, will be levied on the property in addition to the ordinary rates. The amount of this rate is to be such that it will be sufficient to discharge

the expenses, plus interest thereon at the rate of 5 per cent. per annum, within such period not exceeding 30 years as may be determined by the local authority in each particular case.

30. Arbitration. — Many of the Acts of Parliament, among which is the Public Health Act, 1875, provide for **arbitration.** An **arbitrator** is a person appointed for the purpose of determining the questions at issue between the parties to a dispute. Although he is often required to settle disputes in which sums of money are concerned, his position is not that of a *valuer*. His duties are of a judicial nature, whereas a valuer is required merely to state the worth of some work, property, or other thing which may be capable of being valued. Any person may be appointed an arbitrator provided that he has no appreciable interest in the matters in dispute. Preference, however, is usually given to a person having special technical knowledge in regard to matters similar to those which are under consideration.

31. The subjects in respect of which reference to an arbitrator is desired should be stated in writing, and the arbitrator must not deal with matters outside the limits thus defined. A case may be dealt with by a single arbitrator, if the parties in the dispute can agree as to his appointment, or, if the Act under which the arbitration is conducted provides that where the parties cannot agree on this question an arbitrator is to be appointed, by some unbiassed body. The alternative arrangement is for an arbitrator to be appointed by each of the two parties to the dispute. The two arbitrators thus appointed must, before entering on their task, appoint an umpire to decide between them in the event of their not being able to agree.

32. Arbitration Under Act of 1875.—Section 180 of the Act of 1875 regulates the carrying out of arbitrations under the Act, and provides that when an arbitrator is appointed on behalf of the local authority or any joint-stock company, the appointment must be under the common seal of such authority or company. Neither the officials of a local authority nor the secretary or directors of a joint-stock company have power to bind such authority or company in important matters. All important

documents must be sealed with the common seal of the local authority or company, this alone being evidence that a document is properly authorized. When the appointment is made by any private party, it must be in writing. The notifications of appointment are to be delivered to the arbitrators, and are to be deemed a valid submission to arbitration. Section 181 provides that any question referable to arbitration may, where the amount in dispute is less than £20, be determined in the police court at the option of either party.

PUBLIC HEALTH (BUILDINGS IN STREETS) ACT, 1888

33. Erection of Buildings in Streets.—The frontage lines of buildings abutting on streets are regulated throughout the provincial districts of England and Wales by the provisions of the Public Health (Buildings in Streets) Act, 1888, which deals exclusively with this subject. Section 3 of this Act repeals Section 156 of the Act of 1875, and contains the following requirements:

> It shall not be lawful in any urban district, without the written consent of the urban authority, to erect or bring forward any house or building in any street, or any part of such house or building, beyond the front main wall of the house or building on either side thereof in the same street, nor to build any addition to any house or building beyond the front main wall of the house or building on either side of the same.

The Act does not affect anything done or any right or liability acquired or any security given prior to the passing of the Act. Of course, buildings often are erected beyond the front main wall of the house or building on either side, particularly when the existing buildings are situated a long way back from the road, but this can be done only by consent of the local authority.

PUBLIC HEALTH ACTS AMENDMENT ACT, 1890

34. Application of Act.—In England and Wales the Public Health Acts Amendment Act, 1890, is to be construed as one with the Public Health Acts. In Ireland it is to be construed as one with the Public Health (Ireland) Act, 1878. The Act is divided into five parts: (*a*) General provisions; (*b*) provisions as to telegraph

wires; (*c*) sanitary and other requirements; (*d*) provisions as to the compulsory licensing of places used for public music and dancing; (*e*) laws relating to the raising of loans by the issue of stock by local authorities. Part I of the Act extends to England, except the County of London, and throughout Wales and Ireland; the other parts extend to any district in which they are adopted by resolution of the local authority of such district. Due notice of such proposed resolution must be given to every member of such authority. An urban authority may adopt all or any of the last four parts of the Act. A rural authority may adopt a number of sections in Part III, which are specified in Section 50. Further, under Section 5, the Local Government Board may declare, in the case of rural districts in England and Wales, that any of the provisions of the Act shall apply in any particular rural district.

35. Provisions of Part I of Act.—The provisions of Part I of the Act which should be specially noted are those contained in Section 7. There it provides that

> Any person aggrieved
>
> (*a*) By any order, judgment, determination, or requirement of a local authority under this Act;
>
> (*b*) By the withholding of any order, certificate, licence, consent, or approval which may be made, granted, or given by a local authority under this Act;
>
> (*c*) By any conviction or order of a court of summary jurisdiction under any provision of this Act;
>
> may appeal in manner provided by the Summary Jurisdiction Acts to a court of quarter sessions.

The section, however, does not apply in cases where there is an appeal to the Local Government Board under Section 268 of the Act of 1875, which provides for the recovery in a summary manner of private improvement expenses payable, in instalments, over a period of years. Part I also provides that all the provisions with respect to by-laws contained in Sections 182 to 186 of the Act of 1875 are to apply to all by-laws made by a local authority under the Act of 1890, except by-laws made under Part II of the Act. By court of summary jurisdiction is meant a police court or bench of magistrates.

36. Provisions of Part III of Act.—Part III of the Act of 1890 contains sanitary and other provisions, but none of the provisions of this part applies unless Part III has been adopted by the local authority. Section 17 especially should be studied by an architect erecting a factory building in a district where this part of the Act has been adopted. The requirements of the section are that :

Every person who turns or permits to enter into any sewer of a local authority, or any drain communicating therewith,

(*a*) Any chemical refuse, or

(*b*) Any waste steam, condensing water, heated water, or other liquid, such water or liquid being of a higher temperature than 110° F.,

which, either alone, or in combination with the sewage, causes a nuisance or is dangerous or injurious to health, shall be liable to a penalty not exceeding £10, and to a daily penalty not exceeding £5.

The officials of urban authorities are authorized by the section to enter premises for the purpose of ascertaining whether the provisions of the section are being complied with. Under Section 18, the urban authority are authorized to make connections between drains and sewers upon the cost being paid to them in advance. It is now a very common practice for local authorities to carry out the work of constructing the short length of drain between the last manhole of a drainage system and the public sewer, and of forming the connection with the sewer.

37. Section Amending Act of 1875.—Section 19 is one of the most important sections of the Act of 1890. Its provisions are as follows :

(1) Where two or more houses belonging to different owners are connected with a public sewer by a single private drain, an application may be made under Section 41 of the Public Health Act, 1875, relating to complaints as to nuisances from drains, and the local authority may recover any expenses incurred by them in executing any works under the powers conferred on them by that section from the owners of the houses in such shares and proportions as shall be settled by their surveyor, or, in case of dispute, by a court of summary jurisdiction.

(2) Such expenses may be recovered summarily, or may be declared by the urban authority to be private improvement expenses under the Public Health Act, 1875, and may be recovered accordingly.

(3) For the purpose of this section, the expression drain includes a drain used for the drainage of more than one building.

38. The result of this amendment of the Act of 1875 has been to make the law regarding sewers and drains more complex than before. In districts where Part III of the Public Health Acts Amendment Act, 1890, has not been adopted and where cases are governed by the provisions of the Public Health Act, 1875, the chief point affecting the decision as to the character of a length of pipe is whether or not it is a drain used for the drainage of one building only or premises within the same curtilage. In districts where Section 19 of the Act of 1890 applies, the question of the liability to repair a defective length of pipe receiving the drainage from two or more houses depends also on the ownership of the houses. If the houses belong to different owners and there are no other special circumstances affecting the right of action of the urban authority, such authority can put in force the provisions of Section 19, and can recover any expenses which they may incur. If, however, the houses belong to one owner, the section will not apply, for it deals exclusively with houses belonging to different owners. The provisions of this section were enacted to strengthen the powers of local authorities, but, in the result, they have made the law as to drains and sewers more complicated than it was before.

39. Sanitary Conveniences in Manufactories.—Section 22 of the Act of 1890 provides that every building used as a workshop or manufactory, or where persons are employed or intended to be employed in any trade or business, whether the building may have been erected before or after the adoption of Part III of the Act in any district, must be provided with sufficient and suitable accommodation in the way of sanitary conveniences. In complying with this requirement, regard must be had to the number of persons in the building, and separate accommodation must be provided for each sex. An urban authority, if it appears to them on the report of their surveyor that the provisions of this section are not complied with in the case of any building, may, by notice, require the owner or occupier to provide proper accommodation.

40. Additional By-Laws.—Section 23 of the Act of 1890 provides that Section 157 of the Act of 1875 is to be extended so

as to empower every urban authority to make by-laws with regard to the following matters :

The keeping water-closets supplied with sufficient water for flushing ;

The structure of floors, hearths, and staircases, and the height of rooms intended to be used for human habitation ;

The paving of yards and open spaces in connection with dwelling houses ; and

The provision, in connection with the laying out of new streets, of secondary means of access where necessary for the purpose of the removal of house refuse and other matters.

The section also provides that by-laws, made under Section 157 of the Act of 1875 as thus extended, which have reference to the drainage of buildings, to water-closets, earth-closets, privies, ash-pits, and cesspools in connection with buildings, and to keeping water-closets supplied with sufficient water for flushing, may be made so as to affect existing buildings.

41. Section 23 of the Act of 1890 also provides that rural authorities without any special authorization by the Local Government Board may make by-laws with regard to a number of specified questions. These are the structure of walls and foundations of new buildings for purposes of health ; the sufficiency of air space about buildings, and the ventilation of buildings ; the drainage of buildings ; the provision of water-closets, earth-closets, privies, ash-pits, and cesspools in connection with buildings ; the closing of buildings unfit for human habitation ; the structure of floors ; the height of habitable rooms ; and the keeping of water-closets supplied with sufficient water for flushing. All local authorities are also empowered by the section to make by-laws to prevent buildings which have been erected in accordance with the Public Health Act, 1875, from being altered in such a way that if at first so constructed they would have contravened the Act. The Local Government Board have issued no model code of the by-laws that local authorities may make under the Public Health Acts Amendment Act, 1890, except by-laws with regard to the alteration of buildings. Therefore, local authorities have to draft their own additional by-laws. In doing this, many authorities avail themselves of printed forms. A certain uniformity is thus obtained.

42. General Provisions. — The Public Health Acts Amendment Act, 1890, contains several provisions of less importance than those already mentioned. Section 24 prohibits the use as sleeping rooms of rooms over privies, ash-pits, and cesspools. Section 25 makes it unlawful to erect a new building on land on which any foul animal or vegetable matter has been deposited until such matter has been removed by excavation or otherwise, or has been rendered harmless. Section 33 provides that, where a plan of a new building has been deposited with the local authority and such building was described therein otherwise than as a dwelling house, it is not lawful to use it as a dwelling house without the consent of the local authority. In such case it will be necessary to provide air space at the rear, as required by the Act or by-law in force in such district, and to carry out any structural alterations which the local authority may require to be executed for the purpose of rendering the building fit for use as a dwelling house.

43. The erection of a hoarding in the case of the carrying out of building operations next a street is required by Section 34 of the Act of 1890. Section 35 provides that vaults, arches, and cellars under any street, together with all openings to such, and all cellar-heads, gratings, lights, and coal holes in the surface of a street, and all flagstones of the street or path which support the same, are to be kept in good condition and repair by the owners or occupiers. Means of entrance to and exit from places of public resort are required, by Section 36, to be provided to the satisfaction of the urban authority. By Section 37, platforms erected on public occasions must be safely constructed or secured to the satisfaction of the surveyor of the urban authority.

PRIVATE STREET WORKS ACT, 1892

44. Scope of Act.—The Private Street Works Act, 1892, deals only with the law affecting private streets. It applies only in those urban districts where it has been adopted by the local authority, and in those rural districts where its provisions have been declared to be in force by an order of the Local Government Board. In

the districts where it applies, the Act takes the place of the provisions of the Public Health Act, 1875, with regard to private streets. In it, the procedure, the method of apportionment of expenses, and the character of the premises exempt from the payment of expenses differ from those in the Act of 1875.

45. Method of Procedure. — The procedure that must be adopted in the case of the paving of a private street under the Act of 1892 is very clearly set forth. First, there is the preparation by the surveyor to the local authority of a specification, and also plans and sections if such are applicable to the case. These must be accompanied by an estimate of the probable expenses of the work, and a provisional apportionment of the estimated cost between the owners of the premises liable to be charged. These specification, plans, sections, estimate, and provisional apportionment are submitted to the urban authority for approval, which, when given, must be by resolution. This resolution must be published in a local newspaper, must be publicly posted in or near the street to which it relates, and copies of the resolution must, within 7 days from the date of publication, be served on the owners of the premises shown to be charged in the provisional apportionment. During 1 month from the date of publication, the approved specification, plans, sections, estimate, and provisional apportionments, or certified copies of the same, are to be kept deposited at the offices of the urban authority, and are to be open to inspection at all reasonable times.

46. Within such month, the owner of any premises shown in a provisional apportionment as liable to be charged with any part of the expense of executing the works has the right, by written notice served on the urban authority, to object to the proposals of the urban authority on any of the following grounds:

(*a*) That an alleged street or part of a street is not or does not form part of a street within the meaning of this Act;

(*b*) That a street or part of a street is, in whole or in part, a highway repairable by the inhabitants at large;

(*c*) That there has been some material informality, defect, or error in or in respect of the resolution, notice, plans, sections, or estimate;

(*d*) That the proposed works are insufficient or unreasonable, or that the estimated expenses are excessive;

(*e*) That any premises ought to be excluded from or inserted in the provisional apportionment;

(*f*) That the provisional apportionment is incorrect in respect of some matter of fact to be specified in the objection, or, where the provisional apportionment is made with regard to other considerations than frontage as hereinafter provided, in respect of the degree of benefit to be derived by any persons, or the amount or value of any work already done by the owner or occupier of any premises.

47. Section 8 of the Act of 1892 provides that the urban authority, at any time after 1 month from the date of publication of their resolution, may apply to a police court for a time to be appointed for determining the objections. When this date is settled, a notice of the time and place appointed must be published and copies of the notice served upon the objectors. The court at the time and place appointed will then proceed to hear and determine the objections. The court may quash in whole or in part or may amend the resolution, plans, sections, estimates, and provisional apportionments, and may also determine by whom the costs of the hearing are to be borne.

48. When any private street works carried out under the Act of 1892 have been completed and the actual expenses ascertained, the surveyor is then required, by Section 12, to make a final apportionment, by dividing the expenses in the same proportion as that in which the estimated expenses were divided. Notice of such final apportionment must be served on the owners of the premises affected. The expenses incurred may be recovered by proceedings in the police court or by action in a higher court, or they may, at the discretion of the local authority, be treated as private improvement expenses and made payable by instalments. Within 1 month, however, of the notice of the final apportionment, the owner of any premises charged may, by written notice to the urban authority, object to the final apportionment on all or any of the following grounds:

(*a*) That the actual expenses have without sufficient reason exceeded the estimated expenses by more than 15 per cent.;

(*b*) That the final apportionment has not been made in accordance with this section;

(*c*) That there has been an unreasonable departure from the specification, plans, and sections.

Objections to the final apportionment are to be determined in the police court in a similar manner to objections to the provisional apportionment.

49. Manner of Apportionment.—Section 10 of the Act of 1892, which deals with the manner in which expenses are to be apportioned, provides that, unless the urban authority otherwise resolve, the expenses are to be apportioned according to the frontage of the respective premises which front, adjoin, or abut on the street. The urban authority, however, may, if they think just, resolve that in settling the apportionment regard is to be had to the following considerations :

(*a*) The greater or less degree of benefit to be derived by any premises from such work ;

(*b*) The amount and value of any work already done by the owners and occupiers of such premises.

They may also, if they think just, include any premises which do not front, adjoin, or abut on the street, but which are approached from the street through a court, passage, or in some other manner, if such in their opinion will be benefited by the works, and they may fix the sum or proportion to be charged against such premises. The provisions of this section constitute one of the chief points of difference between the Act of 1892 and the private street requirements of the Act of 1875; for, under the latter Act, the apportionment of expenses is in all cases governed by the lengths of the respective frontages of the premises involved.

50. Lands and Premises Exempt.—Section 16 of the Private Street Works Act, 1892, provides that the incumbent or minister or trustee of any church, chapel, or place appropriated for public religious worship which is exempt from the poor rate is not to be liable for private street work charges. The expenses in respect of which any such exemption is granted are to be paid by the urban authority. This provision is similar to that in the Act of 1875. There is, however, a further exemption which affects very considerably the owners of adjoining property. Section 22 provides that in streets formed after the adoption of the Act, no railway or canal company shall be chargeable with private

street expenses in respect of land fronting or abutting on a street which is being dealt with under the Act, if such land is used by the company solely as a part of their line of railway, canal, siding, station, towing-path, or works, and has no direct communication with such street. The expenses which would otherwise be chargeable in respect of such land are to be paid by the owners of the other property in the street in such proportion as may be settled by the surveyor to the local authority. If, however, at any future time the company make a communication between such land and the street, they must pay the urban authority the expenses to which they would have been liable if such communication had existed at the time that the apportionments for private street expenses were made. The urban authority must then divide this amount among the owners included in the original apportionment, after deducting the cost and expenses attendant on such division. The apportionment among the owners is to be settled by the surveyor to the urban authority, whose decision is final.

FACTORY AND WORKSHOP ACT, 1901

51. Means of Escape in Case of Fire.—Under the Factory and Workshop Act, 1901, district councils are required to see that factories and workshops in their district in which more than 40 persons are employed are provided with means of escape in case of fire. The law in this respect is the same throughout the whole of the British Isles, including London, where the County Council exercise the powers conferred by the Act on district councils. Section 14 provides that every factory whose construction was not commenced before 1892, and in which more than 40 persons are employed, and every workshop whose construction was not commenced before 1896, and in which more than 40 persons are employed, must be furnished with a certificate from the local authority to the effect that the factory or workshop is provided with such means of escape in case of fire for the persons employed therein as can reasonably be required under the circumstances of the case. The distinction between a factory and workshop is, broadly speaking, one of the use or

otherwise of machinery. When hand labour only is employed in any premises, such premises are, in all ordinary cases, a **workshop** and not a **factory.**

52. The section further provides that all factories and workshops constructed prior to the dates specified, in which more than 40 persons are employed, are to be furnished with proper means of escape. The local authority are able by notice to require the provision of means of escape from premises thus occupied. The means of escape required is to be specified in the notice. In the case of a difference of opinion between the owner of the factory or workshop and the local authority, the question may be referred to arbitration on the application of either party at any time within 1 month from the time when the difference arises. If, after the works are done, the owner alleges that the occupier of the factory or workshop ought to bear or contribute to the expenses of complying with the requirement, he may apply to the county court, and the court may make such order with regard to the expenses as may appear to be just and equitable.

PUBLIC HEALTH ACTS AMENDMENT ACT, 1907

53. Applicability of Requirements.—Any part or any section of the Public Health Acts Amendment Act, 1907, may be incorporated in the building law of a district at the desire of the local authority. This is different from the procedure to be adopted under the Act of 1890, where, if an urban authority desire to make use of the provisions of a section, they must adopt the whole part of the Act in which such section occurs. As the Act of 1907 is only a few years old, many authorities have not yet made use of its provisions, but in a few years it is probable that the chief sections will be incorporated in the building law of most districts.

54. Minor Provisions.—Section 15 of the Act of 1907 provides that when plans are deposited and the consent obtained is not acted on within 3 years of the date of the deposit of such plans, the consent shall lapse. In such an event, if it is desired at some later time to proceed with the work it will be necessary to

apply for a new consent. Section 22 provides that a local authority may require the corners of buildings at the corner of two streets to be splayed or rounded off, but they must in such case pay compensation to the owner.

55. Operations Constituting Erection of New Building.—Section 23 of the Act of 1907 provides that for the purpose of the Public Health Acts, and any by-laws made thereunder, each of the following operations is to be termed the erection of a new building:

(*a*) The re-erection wholly or partially of any building of which an outer wall is pulled down or burnt down to or within *10 feet* of the surface of the ground adjoining the lowest story of the building, and of any frame building so far pulled down or burnt down as to leave only the framework of the lowest story;

(*b*) The conversion into a dwelling house of any building not originally constructed for human habitation, or the conversion into more than one dwelling house of a building originally constructed as one dwelling house only;

(*c*) The re-conversion into a dwelling house of any building which has been discontinued as or appropriated for any purpose other than that of a dwelling house;

(*d*) The making of any addition to an existing building by raising any part of the roof, by altering a wall, or making any projection from the building, but so far as regards the addition only; and

(*e*) The roofing or covering over of an open space between walls or buildings.

This section, in districts which avail themselves of its provisions, takes the place of the definition of new building contained in Section 159 of the Public Health Act, 1875. The definition in the Act of 1907 is much more stringent than the older one. As the applicability or otherwise of the by-laws to any work is determined by the question of whether or not the work constitutes the erection of a new building, it is evident that these definitions are very important.

56. Further By-Laws.—The local authority of any district are empowered to make by-laws:

(*a*) With respect to the height of chimneys of buildings and with respect to the height of buildings; and

(*b*) With respect to the structure of chimney shafts for the furnaces of steam engines, breweries, distilleries, or manufactories.

Local authorities availing themselves of the powers conferred by this section are able to make their building requirements coincide, in some important respects, with those of the Metropolis. Few local authorities at present limit the height of buildings in their districts, but there is a tendency for the practice to become more general.

57. Submission of Plans for Temporary Buildings.—Section 27 of the Act of 1907 provides that, before a person sets up a temporary building, he must make an application, accompanied by plans, to the local authority for the purpose of obtaining their consent. The authority are required within 1 month after the delivery of the plans to express their approval or disapproval. The following buildings are, however, exempted: Any building exempted from the Public Health Acts or by-laws ; any building set up to protect or prevent the acquisition of rights of light ; any temporary building set up as part of a builder's plant.

58. Sanitary Fittings and Drainage.—Under Section 39 of the Act of 1907, a local authority, in a case where there is a sufficient water supply and a sewer, may require proper water-closet accommodation to be provided in new buildings, and also may require closet accommodation in existing buildings to be converted into water-closet accommodation. These requirements are very drastic and are hardly likely to come into general operation in the near future, for the provision of privy or earth-closet accommodation is very common in the poorer districts of many towns. Section 45 gives the local authority powers with regard to the inspection of existing drainage. It provides that, where the medical officer of health, or the surveyor, or the inspector of nuisances of any district reports to his authority that he has reasonable grounds for believing that the drains are so defective as to be injurious or dangerous to health, the local authority may authorize such official to apply the smoke test or some test of a similar character. The water test may not be applied under the provisions of the section. It is provided that, before the smoke or other test is applied, the consent of the owner of the premises must be obtained, or, if this is not given, an authorization of the test must be obtained from a magistrate.

If a drain is found to be defective, the local authority can by notice require the execution of the works necessary to put it in good order. If the notice is not complied with, the local authority may do the work and recover any expenses which they may incur.

MODEL BY-LAWS FOR URBAN DISTRICTS

DEFINITIONS AND EXEMPTIONS

59. Summary of By-Laws.—In order that a general idea of the requirements likely to be found in a set of local by-laws may be obtained, a general summary of the model by-laws is given here. First the urban by-laws which have formed the basis of the by-laws of practically all cities, boroughs, and urban districts in England and Wales are dealt with. This model code has been adopted to a considerable extent in many rural districts. The model code for rural districts is then analyzed. The provisional draft of more stringent by-laws for rural districts issued by the Local Government Board is not considered of sufficient importance to demand special treatment. In reading through these by-laws it must be remembered that they are models only, and that the detail of the numerous requirements will vary in different districts. Further, many districts have made by-laws under the Public Health Acts Amendment Acts, 1890 and 1907, and have requirements additional to those in any model code.

60. Definitions of Terms.—In the urban model by-laws the principal terms applying throughout the whole of the code are specially defined. Leaving out the definition of the district in which the by-laws apply, the definitions are as follows :

Base applied to a wall means the under side of the course immediately above the footings, if any, or, in the case of a wall wholly carried by a bressummer, the under side of the course immediately above the bressummer.

Party wall means :

(*a*) A wall forming part of a building and being used or constructed to be used in any part of the height or length of such wall for separation of adjoining buildings belonging to different owners or occupied or constructed or adapted to be occupied by different persons ;

(*b*) A wall forming part of a building and standing, in any part of the length of such wall, to a greater extent than the projection of the footings on one side on grounds of different owners.

External wall means an outer wall of a building not being a party wall, even though adjoining to a wall of another building.

Public building means a building used or constructed or adapted to be used, either ordinarily or occasionally, as a church, chapel, or other place of public worship, or as a hospital, workhouse, college, school (not being merely a dwelling house so used), theatre, public hall, public concert room, public ball-room, public lecture room, or public exhibition room, or as a public place of assembly for persons admitted thereto, by tickets or otherwise, or used or constructed or adapted to be used, either ordinarily or occasionally, for any other public purpose.

Building of the warehouse class means a warehouse, factory, manufactory, brewery, or distillery.

Domestic building means a dwelling house or an office building, or other out-building appurtenant to a dwelling house, whether attached thereto or not, or a shop, or any other building not being a public building, or of the warehouse class.

Dwelling house means a building used or constructed or adapted to be used wholly or principally for human habitation.

Bressummer means a wooden beam or a metal girder which carries a wall.

Width, applied to a new street, means the whole extent of space intended to be used, or laid out so as to admit of being used, as a public way, exclusive of any steps or projections therein, and measured at right angles to the course or direction or intended course or direction of such street.

61. Wholly Exempted Buildings.—The urban model by-laws contain a long list of buildings which are either wholly or partially exempt from such by-laws. Some of the buildings are wholly exempt because of the public importance of the purpose for which they are erected, or because of the character of their use considered together with their size and their distance from streets and neighbouring buildings. In the first class are buildings in His Majesty's possession or used for His Majesty's service, any county or borough lunatic asylum, any building or part of a building belonging to the council of any county, city, or borough, and used for the detention of prisoners, any prison, and any building occupied by any prison officer for the use of a prison and situated contiguous thereto. The following buildings, belonging for the most part to companies, are also included in this class: Any building, not being a dwelling house, which

belongs to any person or body of persons authorized by any Act of Parliament to navigate or use any river, canal, dock, harbour, or basin ; any building, not being a dwelling house, which is erected in connection with any mine, and used or intended to be used exclusively for the working of such mine ; any building erected according to plans approved by the Land Commissioners for England, or the Board of Agriculture and Fisheries under the Improvement of Land Act, 1864, or other Act or Acts for the improvement of land. It also includes any building which may not be exempt by the operation of any of the preceding clauses, and which is erected in accordance with a plan and in a manner approved under a statutory provision by one of His Majesty's Principal Secretaries of State.

62. In the second section of buildings wholly exempted by the urban model by-laws are those in which the exemption is governed by the character of use, the size, and the distance from streets and neighbouring buildings; they are enumerated in the Act as follows :

(*h*) Any building erected and used, or intended to be erected and used, exclusively for the purpose of a plant house, greenhouse, or conservatory.

(*i*) Any building erected and used, or intended to be erected and used, exclusively for the purpose of an orchard house, summer house, poultry house, boat house, coal shed, garden tool house, potting shed, cycle shed, or aviary which shall not exceed in extent *600 cubic feet*, or which, if exceeding in extent *600 cubic feet*, or if used or intended to be used as a poultry house or aviary, shall be wholly detached, and at a distance of *10 feet* at the least from any other building, not being a building exempt under paragraphs (*h*), (*i*), (*j*), or (*k*) of this by-law.

(*j*) Any building which shall not exceed in height *30 feet*, and shall not exceed in extent *125,000 cubic feet*, and shall not be a public building, and shall not be constructed or adapted to be used either wholly or partly for human habitation, or as a place of habitual employment for any person in any manufacture, trade, or business, and shall be distant at least *8 feet* from the nearest street, and at least *30 feet* from the nearest building not being a building exempt under paragraphs (*h*), (*i*), (*j*), or (*k*) of this by-law, and from the boundary of any adjoining lands or premises.

(*k*) Any building which shall exceed in height *30 feet*, and shall exceed in extent *125,000 cubic feet*, and shall not be a public building, and shall not be constructed or adapted to be used either wholly or partly for human habitation, or as a place of habitual employment for any person in any manufacture, trade, or business, and shall be distant at least *30 feet* from

the nearest street, and at least *60 feet* from the nearest building not being a building exempt under paragraphs (*h*), (*i*), (*j*), or (*k*) of this by-law, and from the boundary of any adjoining lands or premises.

(*l*) Any building erected or intended to be erected for use solely as a temporary hospital for the reception and treatment of persons suffering from any dangerous infectious disorder.

For the purposes of this by-law, the height of a building shall be measured from the level of the ground adjoining the walls to half the vertical height of the roof.

63. Partially Exempted Buildings.—The buildings which are partially exempted by the urban model by-laws are subject to all the by-laws except those dealing with general construction, other than requirements with regard to fireplaces and smoke flues. Such partially exempted buildings are :

Any building which comprises not more than one story, the external walls of which shall be constructed of, or wholly covered with, galvanized, corrugated, or other sheet iron, which shall not be constructed or adapted to be used either wholly or partly for human habitation, and which shall not exceed *30 feet* in height nor *80,000 cubic feet* in capacity.

Provided that such building

(*a*) If it does not exceed *2,000 cubic feet* in capacity, shall be distant at least *10 feet* from the boundary of any adjoining lands or premises not being a street ;

(*b*) If it exceeds *2,000 cubic feet*, but does not exceed *15,000 cubic feet* in capacity, shall be distant at least *8 feet* from the nearest street, and at least *15 feet* from the nearest building, and from the boundary of the adjoining lands or premises ;

(*c*) If it exceeds *15,000 cubic feet* in capacity, shall be distant at least *8 feet* from the nearest street, and *30 feet* from the nearest building, and from the boundary of any adjoining lands or premises.

For the purposes of this by-law height shall be measured from the level of the ground adjoining the walls to half the vertical height of the roof of the building.

FORMATION OF NEW STREETS

64. Level and Width of Streets. — Every person forming a new street must lay it out at such a level that it will afford the easiest practicable gradients or slopes throughout its length for the purpose of securing easy and convenient means of communication with any street with which it may connect. When it forms the principal means of access and is over 100 feet long, it must be laid out as a carriage road, and be at least 36 feet wide. Where

such a street does not exceed 100 feet in length the width may be not less than 24 feet. Where a new street forms only a secondary means of access to any premises, its width must be at least 16 feet, unless the length of the street does not exceed 100 yards, when the width may be 13 feet. Every person constructing a new street is required to provide that one end, at least, of such street shall be open from the ground upwards for the full width of the street.

65. Many authorities require a greater width than that stated in the model by-laws in the case of streets laid out as carriage roads. A width of 40 feet is often required in the larger towns, and in some districts 45 feet. The width of streets specified in the local by-laws is a most important matter to an architect laying out an estate for building purposes, for where wide streets are required, the cost of the development of the estate is greatly increased owing to the large sum required to construct the streets.

66. Construction of Streets.—The rules in the model by-laws which must be followed by a person carrying out the detailed construction of streets for use as carriage roads are :

(*a*) He shall construct the carriageway of such street so that the width thereof shall be *24 feet* at the least.

(*b*) He shall construct the surface of the carriageway of such street so as to curve or fall from the centre or crown of such carriageway to the channels at the sides thereof, the height of the crown of such carriageway above the level of the side channels being calculated at the rate of not less than $\frac{3}{8}$ *inch* and not more than $\frac{3}{4}$ *inch* for every *foot* of the width of such carriageway.

(*c*) He shall construct on each side of such street a footway of a width not less than *one-sixth* of the entire width of such street.

(*d*) He shall construct each footway in such street so as to slope or fall toward the kerb or outer edge at the rate of $\frac{1}{2}$ *inch* in every *foot* of width, if the footway be not paved, flagged, or asphalted, and at the rate of not less than $\frac{1}{4}$ *inch* and not more than $\frac{1}{2}$ *inch* in every *foot* of width, if the footway be paved, flagged, or asphalted.

(*e*) He shall construct each footway in such street so that the height of the kerb or outer edge of such footway above the channel of the carriageway, except in the case of crossings paved or otherwise formed for the use of foot passengers, shall be not less than *3 inches* at the highest part of such channel and not more than *7 inches* at the lowest part of such channel.

These rules are of a good practical nature, and if committed to memory will serve as a useful guide in preparing drawings for the construction of streets.

CONSTRUCTION OF BUILDINGS

67. Sites and Foundation of Buildings.—The model by-laws provide that no person may erect a new building on a site which has been filled up with foul animal or vegetable matter until such matter has been removed from the site. The surface of the ground under a new domestic building must be covered with a layer of good cement concrete at least 6 inches thick, or 4 inches thick if properly grouted. The majority of districts require, without reservation, a 6-inch thickness. If the proposed site of the building is in a clay pit or other excavated hollow, the site may have to be elevated. In low-lying districts, provision is made for a requirement to the effect that the floor of the lowest story must be a specified height above the *ordnance datum*. This is the mean level of the sea at Liverpool. Levels on ordnance survey maps are given in feet above this datum.

68. Construction of Walls.—Every person erecting a new building is required to construct the external and party walls of the following materials :

Good bricks, stone, or other hard and incombustible materials, properly bonded and solidly put together :

(i) With good mortar compounded of good lime and clean sharp sand, or other suitable material ; or

(ii) With good cement ; or

(iii) With good cement mixed with clean sharp sand.

Every cross-wall which is to be considered as a return wall must be similarly constructed.

69. There are two important cases in which the requirements just stated need not be complied with. Buildings, without consideration of size or position, may be constructed with hollow walls, and the external enclosures of a building at specified distances from other buildings, or forming one of a small group of buildings, may be constructed of timber framing. The

requirements with regard to hollow walls affect the detailed construction of such walls, and are as follows:

(i) The inner and outer parts of the wall shall be separated by a cavity, which shall throughout be of a width not exceeding $2\frac{1}{2}$ *inches*, and shall be properly drained and ventilated.

(ii) The inner and outer parts of the wall shall be securely tied together with suitable bonding ties of adequate strength formed of galvanized iron, of iron tarred and sanded, or of glazed stoneware. Such ties shall be placed at distances apart not exceeding *3 feet* horizontally and *18 inches* vertically.

(iii) The thickness of each part of the wall shall throughout be not less than $4\frac{1}{2}$ *inches*.

(iv) The aggregate thickness of the two parts, excluding the width of the cavity, shall throughout be not less than the minimum thickness prescribed by the by-law in that behalf for an external wall of the same height and length, and belonging to the same class of building as that to which the hollow wall belongs.

(v) All woodwork which may be intended to form the head of a door frame or window frame, a lintel, or other similar structure, and may be inserted in the wall so as to project into or extend across the intervening cavity, shall be covered throughout on the upper side thereof with a layer of sheet lead or other suitable material impervious to moisture in such a manner as effectually to protect such woodwork from any moisture that may enter the cavity.

70. The construction of timber-framed external enclosures to buildings may be carried out only under the following conditions and in accordance with the rules specified:

Where a new domestic building shall be distant not less than *15 feet* from any other building not being in the same curtilage, the person erecting such new building may construct its external walls of timber framing, subject to compliance with the following conditions, that is to say:

(i) The timber framing shall be properly put together, and the spaces between the timbers shall be filled in completely with brickwork or other solid and incombustible material.

(ii) A thickness of at least $4\frac{1}{2}$ *inches* of brickwork or other solid and incombustible material shall be placed at the back of every portion of timber.

Where a new domestic building forms or is intended to form part of a block of new domestic buildings not exceeding *three* in number, and each of which shall be distant not less than *15 feet* from any other building, not being in the same curtilage and not forming part of the same block, the person erecting such new building may construct its external walls

of timber framing, subject to compliance with the following conditions, that is to say :

(i) The several buildings shall be separated by party walls, each of which shall be constructed in accordance with the requirements of the by-laws in that behalf, and shall project at least *1 inch* in front of any timber framing in any adjoining external wall.

(ii) The timber framing shall be properly put together, and the spaces between the timbers shall be filled in completely with brickwork or other solid and incombustible material.

(iii) A thickness of at least $4\frac{1}{2}$ *inches* of brickwork or other solid and incombustible material shall be placed at the back of every portion of timber.

Where a new domestic building which comprises *two* or more stories shall be distant not less than *15 feet* from any other building not being in the same curtilage, or forms, or is intended to form, part of a block of new domestic buildings not exceeding *three* in number, and each of which shall be distant not less than *15 feet* from any other building, not being in the same curtilage and not forming part of the same block, the person erecting such new building may construct the external walls of the topmost story, or if the building comprises more than *two* stories, of the topmost *two* stories, of timber framing covered with tiles, slates, or other suitable incombustible material, subject to compliance with the following conditions, that is to say :

(i) The timber framing shall be properly put together, with sufficient braces, ties, plates, and sills.

(ii) So much of any external wall as is below that portion which may be of timber framing covered with tiles, slates, or other suitable incombustible material, shall be constructed of the same thickness and in other respects subject to the same conditions as would be applicable if the wall had been constructed throughout its whole height of good bricks, stone, or other hard and incombustible materials.

(iii) Every party wall in any such block of buildings shall be carried out at least to the external face of any timber framing in any adjoining external return wall.

71. Detailed Requirements as to Construction.—No portion of a wall is allowed to overhang the part beneath. All walls which meet at an angle are to be properly bonded with one another. Every wall which does not rest upon a bressummer must have footings which project on either side equal to one-half the thickness of the wall at the base, and have a height equal to two-thirds of such thickness. They must rest upon the solid ground, a sufficient thickness of concrete, or some solid and sufficient substructure. Every wall of a new public or domestic building

must have a proper damp-proof course of sheet lead, asphalt, or slates laid in cement or other not less durable material. The level of such damp-proof course must not be less than 6 inches above the surface of the adjoining ground. In the majority of districts this by-law is made to apply to all buildings irrespective of their character.

72. Where any part of the lowest story of a building is carried below the level of the surface of the ground, and such story is not used merely as a cellar for storage purposes, such parts as are in contact with the ground must be enclosed with walls impervious to moisture or with hollow walls. This special walling must extend upwards at least 6 inches above the surface of the ground. A damp-proof course in such a case is to be inserted both at the base of the wall and 6 inches above the surface of the ground. This provision of a second damp-proof course is, in a case of this character, a very desirable arrangement, even though it may not be required by the local by-laws.

73. Thickness of Walls.—Walls, whether external, party, or cross-walls, are regulated as regards their thickness by the character of the building to which they belong and also by their height and length. It is also necessary to consider the height of stories, for when, in the case of a domestic building, the height of a story exceeds 16 times, and, in the case of a public building or a building of the warehouse class, 14 times, the thickness of the wall, the thickness must be increased to within these limits. Such increased thickness may be confined to piers properly distributed, the collective widths of which amount to one-fourth the length of the wall. The respective methods of measurement to be adopted in determining the height of a story and the height and length of a wall are stated in the by-laws as follows :

(i) The height of a story shall be measured in the case of the lowest story from the base of the wall, and in the case of any other story from the level of the upper surface of the floor of the story up to the level of the upper surface of the floor of the story next above it ; or, if there be no such story, then up to the highest part of the wall.

(ii) The height of a wall shall be measured from the base to the highest part of the wall, or, in the case of a wall comprising a gable, to half the height of the gable : Provided that in the case of a party wall comprising

a gable the measurement shall be from the base of the wall to the level of the base of the gable.

(iii) Walls shall be deemed to be divided into distinct lengths by return walls. The length of a wall shall be measured from the centre of one return wall to the centre of another, provided that the return walls are external walls, party walls, or cross-walls, of the thickness prescribed by the by-laws, and are bonded into the walls so deemed to be divided.

A cross-wall cannot be considered as a return wall unless it is carried up to the top of the wall whose length is under consideration, and unless, in each story, the aggregate superficial area of the recesses and openings in the cross-wall, taken together, does not exceed one-half the superficial area of the wall in such story.

74. The thicknesses of external and party walls constructed of bricks, stone, or blocks of some other hard and incombustible substance laid in horizontal beds or courses have been given in *Brickwork*, Part 2. A cross-wall must be at least two-thirds the thickness of an external wall of a building of the same class, and in no case of less thickness than 9 inches. Walls, whether external, party, or cross-walls, which are constructed of stone, or vitrified lumps of brick or similar material, not laid in horizontal courses, must have a thickness one-third greater than that prescribed for a wall built of bricks. If at least one-fifth of the entire contents of a wall built of brickwork and flintwork is brickwork, which is properly distributed in piers and horizontal courses, the wall may be constructed of the thickness required for a wall made entirely of brick.

75. Openings in External Walls. — Where in any story or stories of a building there is an extent of opening in any external wall which is greater than one-half the whole extent of the wall in the story or stories in which the openings occur, there must be constructed:

(*a*) Sufficient piers of brickwork or other sufficient supports of incombustible material so disposed to carry the superstructure; and

(*b*) A sufficient pier or piers or other sufficient supports of that description at or within *3 feet* of the corner or angle of the building.

76. Parapet Walls.—With the presumed view of preventing the spread of fire from the roof of one building to that of another

building situated on the opposite side of a narrow street or passage, the following by-law is included in the model code :

Every person who shall erect a new public building, a new building of the warehouse class, or a new domestic building which may be intended to be used wholly or partly as a shop or as a place of habitual employment for any person in any manufacture, trade, or business, or which may be intended to be used exclusively as a dwelling house and may exceed *30 feet* in height, shall cause such part of any external wall of such building as is within a distance of *15 feet* from any other building to be carried up so as to form a parapet *1 foot* at least above the highest part of any roof or gutter which adjoins such part of such external wall, and he shall cause the thickness of the parapet so carried up to be at least *9 inches* throughout.

Many local by-laws, however, are framed so as to admit of the finish of the roofs of all buildings by means of eaves gutters.

77. Carrying Up Party Walls.—It is recognized by all persons who have studied the question of fire prevention that one of the greatest obstacles to the spread of a fire is a properly constructed party wall carried up above the roofs. The model by-laws consequently provide that in buildings which are subjected to a greater fire risk than ordinary dwelling houses, the party walls must be carried up above the roofs of the buildings which they separate. The detailed requirements are :

Every person who shall erect a new public building, a new building of the warehouse class, or a new domestic building which may be intended to be used wholly or partly as a shop or as a place of habitual employment for any person in any manufacture, trade, or business, or which may be intended to be used exclusively as a dwelling house and may exceed *30 feet* in height, shall cause every party wall of such building to be carried up *9 inches* at the least in thickness :

(*a*) Above the roof, flat, or gutter of the highest building adjoining thereto to such height as will give, in the case of a public building or of a building of the warehouse class, a distance of at least *3 feet*, and, in the case of any such domestic building as is hereinbefore described, a distance of at least *15 inches* measured at right angles to the slope of the roof, or above the highest part of any flat or gutter, as the case may be ;

(*b*) Above any turret, dormer, lantern light, or other erection of combustible materials fixed on the roof or flat of any building within *4 feet* from the party wall, and so as to extend at least *12 inches* higher and wider on each side than such erection ;

(*c*) To a height of *12 inches* at the least above such part of any roof as is opposite to and within *4 feet* from the party wall.

Where the eaves of the roofs project beyond the face of the building, the party walls are to be corbelled out in brickwork or stonework to the full extent of the projection.

78. In the case of the party walls to dwelling houses and offices, where the risk of fire is not so great, the requirements of the by-laws are less stringent.

Every person who shall erect a new domestic building which may be intended to be used exclusively as a dwelling house and may not exceed *30 feet* in height, or which may be intended to be used as an office building or other outbuilding appurtenant to a dwelling house whether attached thereto or not, shall cause every party wall of such building to be carried up at least as high as the under side of the slates or other covering of the roof of such building; and if such party wall be carried up only to the under side of such slates or other covering, he shall cause such slates or other covering to be properly and solidly bedded in mortar or cement on the top of the wall.

He shall also cause the roof to be so constructed that no lath, timber, or woodwork of any description shall extend upon or across any part of such wall.

Although the by-laws of a considerable number of districts require the party walls of dwelling houses and offices to be carried up at least 15 inches above the roofs, there is a strong feeling among architects that the carrying of such walls to the under side of the slates is quite a sufficient fire precaution. For the purpose of this by-law with regard to carrying up of party walls above roofs, the height of a building is to be measured from the top of the footings to the level of half the vertical height of the roof, or to the top of the parapet, whichever may be the higher.

79. **Recesses in External and Party Walls.**—As the stability of buildings might be seriously affected if persons were allowed to make as many recesses in a wall as they might please, the model by-laws limit the amount of allowable recess. The rules as to recesses, together with those with regard to the cutting of chases in walls, are as follows:

A person who shall erect a new building shall not make any recess in any external wall or party wall of such building:

(*a*) Unless the back of such recess be at the least *9 inches* thick;

(*b*) Unless a sufficient arch be turned or a lintel of incombustible material placed in every story over every such recess;

(*c*) Unless in each story the aggregate extent of recesses having backs of less thickness than the thickness prescribed by any by-law in that behalf for the wall in which such recesses are made do not exceed *one-half* of the extent of the vertical superficies of such wall;

(*d*) Unless the side of any such recess nearest to the inner face of any return external wall is distant at the least $13\frac{1}{2}$ *inches* therefrom.

A person who shall erect a new building shall not make in any wall of such building any chase which shall be wider than *14 inches* or more than $4\frac{1}{2}$ *inches* deep from the face of such wall, or shall leave less than *9 inches* in thickness at the back or opposite side thereof, or which shall be within $13\frac{1}{2}$ *inches* from any other chase, or within *7 feet* from any other chase on the same side of such wall, or within $13\frac{1}{2}$ *inches* from any return wall.

In some districts, the requirements are made more stringent in the case of recesses in party walls.

80. Rules as to Timber in Walls.—No person is allowed to place a bond timber or wooden plate in any party wall. No bressummer, beam, or joist must be placed in a party wall so as to extend within $4\frac{1}{2}$ inches from the centre of such wall. It is provided, however, that where a party wall does not exceed 9 inches in thickness, such timbers may extend to the centre of the party wall provided that they are encased at the ends with not less than $4\frac{1}{2}$ inches of solid brickwork. In districts where no such proviso appears, timbers must in all cases be kept $4\frac{1}{2}$ inches from the centre lines of party walls. Every bressummer is required to be borne by a sufficient template of stone, iron, terra-cotta, or other vitrified stoneware of the full breadth of the bressummer, and the bressummer must have a bearing of at least 4 inches on the template at each end. A bressummer, if necessary, is to be provided with such story posts, iron columns, stanchions, or piers of brick or stone as may be required to carry the superstructure.

81. Rules as to Chimneys and Flues.—A chimney must be built on solid foundations and must have footings similar to those of the wall against which it is built, unless it is built on a metal girder, or on sufficient corbels of brick, stone, or other hard and incombustible materials. In this latter case, the work corbelled out must not project from the wall to a greater extent than the thickness of the wall, measured immediately below the

corbel. Every smoke flue is required to be pargeted inside or lined with fireproof piping at least 1 inch thick. The outside of a flue which does not form part of the outer face of an external wall is to be rendered when the brickwork is less than 9 inches thick. Every flue intended for use in connection with a furnace, boiler, or close-fire constructed for any purpose of trade, business, or manufacture, or in connection with any cooking range, or in connection with the cooking apparatus of any hotel, tavern, or eating house, is required to be surrounded by brickwork or other solid and incombustible material at least 9 inches thick for a distance of at least 10 feet in height from the floor on which such furnace or other heating or cooking apparatus is placed.

82. All the requirements mentioned tend toward sound construction. The following can with advantage be committed to memory, as they form good constructional rules affecting all classes of buildings:

Every person who shall erect a new building shall cause a sufficient arch of brick or stone, or a sufficient stone lintel, or a sufficient bar of wrought iron to be built over the opening of every chimney of such building to support the breast of such chimney; and if the breast projects more than $4\frac{1}{2}$ *inches* from the face of the wall, and the jamb on either side is of less width than $13\frac{1}{2}$ *inches*, he shall cause the abutments to be tied in by a bar or bars of wrought iron of sufficient strength, *18 inches* longer than the opening, turned up and down at the ends, and built into the jambs on each side.

Every person who shall erect a new building shall cause the jambs of every chimney of such building to be at least *9 inches* wide on each side of the opening of such chimney.

Every person who shall erect a new building shall cause the breast of every chimney of such building and the brickwork or stonework surrounding every smoke flue and every copper flue of such building to be at least $4\frac{1}{2}$ *inches* in thickness.

Every person who shall erect a new building shall cause the back of any chimney opening in a party wall and the back of the flue connected therewith in any room which may be constructed for occupation as a kitchen to be at least *9 inches* thick to the height of at least *9 feet* above the hearth.

Such person shall cause the back of every other chimney opening in such building, from the hearth up to the height of *12 inches* above such opening, to be at least $4\frac{1}{2}$ *inches* thick in the case of an external wall, and *9 inches* thick in the case of any other wall.

Every person who shall erect a new building shall cause the upper side of every flue of such building, when the course of such flue makes with the horizon an angle of less than *45°*, to be at least *9 inches* in thickness.

Every person who shall erect a new building shall cause every chimney shaft or smoke flue of such building to be carried up in brickwork or stonework all round at least $4\frac{1}{2}$ *inches* thick to a height of not less than *3 feet* above the roof, flat, or gutter adjoining thereto, measured at the highest point in the line of junction with such roof, flat, or gutter.

A person who shall erect a new building shall not cause the brickwork or stonework of any chimney shaft of such building, other than a chimney shaft of the furnace of any steam engine, brewery, distillery, or manufactory, to be built higher above the roof, flat, or gutter adjoining such chimney shaft, measured from the highest point in the line of junction with such roof, flat, or gutter, than a height equal to *6* times the least width of such chimney shaft at the level of such highest point, unless such chimney shaft shall be built with and bonded to another chimney shaft not in the same line with such first-mentioned chimney shaft, or shall be otherwise made secure.

83. The model by-laws contain several detailed requirements designed to prevent the outbreak of fire. These concern principally the placing of combustible and other material near to flues and chimney openings. An iron holdfast or other metal fastening is not to be placed nearer than 2 inches to the inside of any flue or chimney opening. Woodwork placed in any wall or chimney breast is not to be nearer than 9 inches to the inside of any flue or chimney opening. Woodwork is not to be placed under any chimney openings within 10 inches from the upper surface of the hearth. A wooden plug must not be driven into any wall or chimney breast within a distance of 6 inches from any timber or woodwork. Where woodwork comes within 2 inches of the face of the brickwork of any flue or chimney opening, which brickwork is less than 9 inches in thickness, the face of the brickwork is to be rendered. An opening made in any chimney or flue for inserting a ventilating valve or for any other purpose must be at least 9 inches from any timber or other combustible substance. Any pipe for the purpose of conveying smoke or other products of combustion must not be fixed within 9 inches of any combustible substance.

84. Construction of Roofs.—In order to prevent the outbreak of fire by sparks dropping on a roof, and to prevent the easy

spread of fire from roof to roof in any case where a conflagration may have already come into existence, the following by-law is included in the model code:

Every person who shall erect a new building shall cause the flat and roof of such building, and every turret, dormer, lantern light, skylight, or other erection placed on the flat or roof of such building, to be externally covered with slates, tiles, metal, or other incombustible materials, except as regards any door, door frame, window or window frame of any such turret, dormer, lantern light, skylight, or other erection.

This requirement has no reference to the main construction of the roof, but merely to the covering. In districts where a by-law to this effect occurs, although some of the patent composition roofing materials may not comply with the by-law, if a roof so covered is finished with a layer of gravel, it would appear that no exception can be taken by the local authority.

OPEN SPACE ABOUT DOMESTIC BUILDINGS

85. Open Space in Front.—The requirements with regard to open space about domestic buildings are in two parts, and have reference to open space in front of buildings and open space at the rear of buildings. It should be particularly noted that the open space requirements apply only to domestic buildings. The requirements as to open space in the front of buildings have practical reference to buildings fronting on old streets or on new streets which are not carriage roads, for where buildings front on new streets laid out as carriage roads the width of the street ensures that the necessary air space is in every case complied with. The requirements for front air space are:

Every person who shall erect a new domestic building shall provide in front of such building an open space, which, measured to the boundary of any lands or premises immediately opposite, or to the opposite side of any street which may not be less than *24 feet* in width at the point where such building may front thereon, shall, throughout the whole line of frontage of such building, extend to a distance of *24 feet* at the least, such distance being measured in every case at right angles to the external face of any wall of such building which shall front or abut on such open space.

Where a new domestic building is to be erected to front a street laid out before the confirmation of the by-laws and less

than 24 feet wide, the open space in front is to be at least equal to the width of the street, plus one-half of the difference between such width and 24 feet. The open space provided in any case is to be free of any erection above the level of the ground, except any portico, porch, or like projection, or any gate, fence, or wall not exceeding 7 feet in height. No person by alterations or additions to a building may reduce the extent of the open space required by by-law.

86. Open Space at Rear.—The requirements as to air space at the rear of buildings are not affected in ordinary cases by the age or character of the street to which the building fronts. Except in the case of stable buildings, the air space is required to extend throughout the whole width of the building. The depth of the space required varies in accordance with the height of the building:

(1) Every person who shall erect a new domestic building shall provide in the rear of such building an open space exclusively belonging to such building, and of an aggregate extent of not less than *150 square feet*, and free from any erection thereon above the level of the ground, except a water-closet, earth-closet, or privy, and an ash-pit, constructed respectively in accordance with the by-laws in that behalf.

In the case of a domestic building not being a building intended and adapted to be used exclusively as a stable, he shall cause such open space to extend throughout the entire width of such building, and he shall cause the distance across such open space, from every part of such building to the boundary of any lands or premises immediately in the rear of the site of such building, to be not less in any case than *10 feet*.

If the height of such building is not less than *15 feet*, but is less than *25 feet*, he shall cause such distance to be *15 feet* at the least.

If the height of such building is not less than *25 feet*, but is less than *35 feet*, he shall cause such distance to be *20 feet* at the least.

If the height of such building is not less than *35 feet* he shall cause such distance to be *25 feet* at the least.

In any case where, by reason of the exceptional shape of the site of such building, the minimum distance across the open space required by this by-law cannot be obtained throughout the entire width of such building, it shall suffice if the mean distance across such open space be not less than the minimum distance so required.

87. Where it is impracticable to comply with the foregoing requirements, special requirements of a less stringent character apply in cases where a building abuts on two or more streets, or

is being re-erected on a site which abuts on an old street. The text of these requirements is as follows :

(i) Where it is intended to erect a new domestic building on a site abutting on two or more streets ; or

(ii) Where it is intended to re-erect a domestic building in a street laid out before the confirmation of these by-laws ;

and it is impracticable to comply with the preceding requirements of this by-law, the said requirements shall be deemed to be satisfied by the provision at the rear or on one side of the site other than the front of such building of an open space exclusively belonging to such building of an extent of at least *150 square feet*, or, in the case of a re-erection of a domestic building, of an extent not less than that of any open space previously provided in connection with such building, and in no case less than *100 square feet*, which shall be free from any erection thereon except a water-closet or earth-closet and an ash-pit, and subject to the following conditions :

(*a*) The open space shall extend throughout at least *10 feet* of the width or depth of such building, and the mean distance across such open space, measured from the opposite part of such building, to the nearest boundary of any street, lands, or premises immediately adjoining such open space, shall be in no case less than *10 feet ;* and

(*b*) If the said open space does not abut on a street, it shall be connected with a street by means of a passage or other similar opening so arranged as to be capable at all times of affording a free circulation of air between the open space and such street.

It is important to notice that the open space in such a case may, if thought desirable, be provided at the side of the building, instead of at the rear, and that the depth of the space does not vary in accordance with the height of the building. On the other hand, however, there is a requirement for the connection of the open space with a street by means of a passage or similar opening, in a case where the open space does not abut on a street.

88. The following proviso, however, applies to all of the requirements with regard to open space at the rear of domestic buildings :

(2) (*a*) This by-law shall not apply so as to require any open space to be provided in the rear of any domestic building other than a dwelling house where such building, not being a stable, is appurtenant to a dwelling house, and is not of a greater height than such dwelling house, and abuts on the open space provided in the rear of such dwelling house, and where the open space so provided is sufficient to comply with the requirements

of this by-law; or where such building being a stable has adjoining and exclusively belonging to it an open space of not less than *150 square feet* in extent.

(*b*) Where any such building, not being a stable, is of a greater height than the dwelling house to which it is appurtenant the foregoing exemption shall not apply unless the open space in the rear of such dwelling house is sufficient to comply with the requirements of this by-law in respect of a dwelling house of the height of the building so appurtenant.

89. No person is allowed to alter or add to a building in such a way that he diminishes the open space required by the by-law. For the purpose of the by-law, which regulates the provision of air space, the height of a building is to be measured from the level of the ground, over which the open space extends, to the level of half the vertical height of the roof or to the top of the parapet, whichever distance may be the greater.

VENTILATION

90. Ventilation of Floor Timbers.—Where the lowest floor of a building is a boarded floor of other than solid construction, a clear space of at least 3 inches must be left between the under side of each joist and the top of the concrete provided over the site of the building. This space must be thoroughly ventilated by means of suitable and sufficient air bricks, so as to prevent dry rot. In practice the distance between the under side of the joists and the top of the concrete is usually very much more than 3 inches.

91. Ventilation of Rooms.—The model by-laws specially require that, in the case of domestic buildings, sufficient windows are to be constructed in the walls abutting on the open spaces provided about such buildings. But this is such an obvious necessity that no such requirement seems to be needed. The by-laws, however, further proceed to deal with the window space and ventilation of habitable rooms and the ventilation of public buildings. The detailed requirements with regard to these matters are:

Every person who shall erect a new building shall construct in every habitable room of such building one window, at the least, opening directly

into the external air, and he shall cause the total area of such window, or, if there be more than one, of the several windows, clear of the sash frames, to be equal at the least to *one-tenth* of the floor area of such room.

Such person shall also construct every such window so that *one-half*, at the least, may be opened, and so that the opening may extend in every case to the top of the window.

Every person who shall erect a new domestic building shall cause every habitable room of such building which is without a fireplace, and a flue properly constructed, and properly connected with such fireplace, to be provided with special and adequate means of ventilation by a sufficient aperture or air shaft which shall provide an unobstructed sectional area of *100 square inches* at the least.

Every person who shall erect a new public building shall cause such building to be provided with adequate means of ventilation.

DRAINAGE AND SANITATION

92. Subsoil Drainage.—Whenever the dampness of a site renders such a precaution necessary, the subsoil of the site is to be properly drained by means of earthenware field pipes laid to a suitable outfall. Such pipes are not to communicate directly with any sewer or cesspool, or with any drain constructed or adapted for conveying sewage, but a suitable trap, with a ventilating opening, must be provided. It will rarely happen that a site is so very damp as to induce the local authority to enforce a requirement for subsoil drainage, but it will not infrequently be desirable in the case of a site which is relatively damp to adopt this precaution, even when not required by the local authority.

93. General Construction of Drains.—Every person erecting a new building is required to provide gutters and rain-water pipes for the purpose of carrying the water to the ground level without causing dampness in any part of the wall or foundation. Every new building must be built so that the lowest story is at such a level as will admit of the effectual drainage of the building and of the provision of the requisite communication with any sewer into which the drain may lawfully empty, at a point in the upper half diameter of such sewer, or with any other means of drainage, such as a cesspool, with which the drain may lawfully communicate. This by-law does not apply to a cellar intended

for storage purposes only, and constructed in a dry soil, or constructed so as to be impervious to water.

94. Detailed Construction of Drains.—The rules with reference to the detailed construction of drains can best be given by quoting the text of the by-laws.

(1) Every person who shall erect a new building shall, in the construction of every drain of such building, other than a drain constructed in pursuance of the by-law in that behalf for the drainage of the subsoil of the site of such building, use good sound pipes formed of glazed stoneware, heavy cast iron, or other equally suitable material.

(2) He shall cause such drain to be of adequate size, and, if constructed or adapted to be used for conveying sewage, to have an internal diameter not less than *4 inches*, and to be laid with a proper fall, and with a socketed or other suitable water-tight joints.

(3) If he shall construct such drain of iron pipes, he shall cause such drain to be properly supported on suitable and sufficient piers or other suitable and sufficient supports, or to be laid in a bed of good concrete.

(4) If he shall construct such drain otherwise than of iron pipes, he shall cause such drain to be laid in a bed of good concrete.

(5) He shall not construct such drain so as to pass under any building, except in any case where any other mode of construction may be impracticable.

If he shall construct such drain so as to pass under any building, he shall cause such drain to be so laid in the ground that there shall be a distance equal at the least to the full diameter thereof between the top of such drain at its highest point and the surface of the ground under such building.

He shall also cause such drain to be laid in a direct line for the whole distance beneath such building, and if constructed otherwise than of iron pipes to be completely embedded in and covered with good and solid concrete, at least *6 inches* thick, all round.

He shall likewise cause adequate means of access to be provided in connection with such drain at each end of such portion thereof as is beneath such building.

(6) He shall cause every inlet to such drain, not being an inlet provided in pursuance of the by-law in that behalf as an opening for the ventilation of such drain, to be properly trapped.

It is provided in another by-law that drains are not to have right-angled junctions, but that branch drains are to join main drains obliquely in the direction of the flow of the sewage. A further by-law provides that connections with drains other than those from water-closets and slop sinks are not to be made within a building.

95. Provision of Intercepting Trap.—Every person erecting a new building is required to provide an intercepting trap to every main drain or other drain which communicates with a sewer or other means of drainage into which the drain may lawfully empty. The intercepting trap is to be placed as far as practicable from the building and as near as practicable to the point at which the drain is connected to the sewer or other means of drainage. The trap must be provided with proper means of access for the purpose of cleansing.

96. Ventilation of Drains.—A system of drainage is required, by the model by-laws, to be ventilated by the provision of at least two untrapped openings to the drains. One opening is to be as near as practicable to the intercepting trap, and the other as far as practicable from it. One of the openings is to be at or near the surface of the adjoining ground and at the other a pipe or shaft is to be carried up vertically to such a height and in such a manner as effectually to prevent any escape of foul air into any building. The minimum height to which such pipe is to be carried in any case is 10 feet. The openings are to be provided with suitable gratings or covers, and the sectional area of the pipes used are to be not less than that of the pipes of the drain, and must not in any case have a smaller diameter than 4 inches. The soil pipe of a water-closet may be considered to provide the necessary opening for ventilation otherwise obtained by carrying up a vertical pipe.

97. It will be noted that the model by-laws do not specify at which end of the drainage system the vertical pipe forming the outlet shaft is to be placed. Unfortunately, however, the by-laws of some districts require this foul-air outlet pipe invariably to be provided at the higher end of the drain. Therefore, before designing a drainage scheme with the outlet pipe placed at the lower end of the drain, an arrangement which for practical reasons may in certain cases be desirable, it will be necessary to consult the local by-laws in order to see whether they admit of such arrangement. If there are very strong reasons for placing the outlet pipe at the lower end of the drain, it may be desirable, should the by-laws appear not to recognize this arrangement, to

approach the officials of the local authority. It may be possible to ascertain from them whether, in spite of the requirement of the by-laws, this method of ventilating may be likely, under the particular circumstances of the case, to receive the favourable consideration of the local authority.

98. Modified rules as to drain ventilation apply when the distance from the water-closet to the intercepting trap does not exceed certain limits. Where this distance is not more than 10 feet, the requirements of the by-law as to drain ventilation do not apply. Where the distance exceeds 10 feet, but is not more than 30 feet, only one opening is required by the model by-laws. This must be as far as practicable from the intercepting trap, and a foul-air outlet pipe must be carried up to form the finish of this opening.

99. Soil Pipes, Wastes, and Overflows.—Soil pipes from water-closets are required to be at least 4 inches in diameter. A soil pipe and any waste pipe from a slop sink must be fixed outside a building and continued upwards without diminution of its diameter, and without any avoidable bends, to such a height and in such a position as to afford an outlet for foul air at a safe distance from windows, chimneys, and other openings. No trap is allowed between the soil pipe and the drain. It is customary in local by-laws to state that soil pipes must be constructed either of drawn lead or of heavy cast iron.

The waste pipe from every bath, lavatory, and sink, other than a slop sink, and every pipe used for carrying off foul waste water, must be properly trapped and taken through an external wall and made to discharge in the open air, either into a channel leading to a trapped gully, or over a gully, or into a gully at a point below the grating, but above the water seal. Overflow pipes from cisterns and from safes of baths and water-closets must be taken through an external wall and made to discharge in the open air.

100. Construction of Water-Closets.—Where a water-closet is constructed within a building, one of the sides of the closet must be an external wall. Such water-closet must be provided with

a window not less than 2 feet by 1 foot in size and opening directly to the outside air. In addition to the window, the water-closet is required to be provided with adequate means of constant ventilation by at least one air brick or by an air-shaft or other effectual appliance. Where a water-closet is constructed outside a building, a sufficient opening must be provided as near the top as convenient and must communicate directly with the outside air. A water-closet must be provided with a proper cistern, and apparatus for flushing, together with a pan and trap. The use of a **D** trap is specially prohibited.

101. Construction of Earth-Closets.—The construction of an earth-closet within a building is governed by the same rules with regard to situation and ventilation as a water-closet. A container of dry earth, together with a receptacle for excreta, must be provided in connection with every earth-closet. When an earth-closet is constructed inside a building, there must be provided a movable receptacle for excreta, having a capacity not exceeding 2 cubic feet. Where an earth-closet is placed outside a building, the receptacle is allowed to be fixed and to have a capacity of 40 cubic feet. The receptacle is to be placed so that the bottom is at least 3 inches above the level of the adjoining ground, and so that it is not exposed to rainfall or to the drainage of waste water or liquid refuse.

102. Construction of Privies, Ash-Pits, and Cesspools.—The model by-laws contain clauses to the effect that every privy, ash-pit, and cesspool are to be placed at a specified distance, differing in every case, from a dwelling house or public building or any building in which a person is or may be employed in any manufacture, trade, or business, and from any well, spring, or other drinking supply. Blank spaces are, however, left in the model code for the distances to be filled in by the various local authorities. As the Local Government Board have in this case left everything to the discretion of the local authorities, a great diversity of practice has arisen. It is therefore practically impossible to give any general rules as to these distances. Privies, ash-pits, and cesspools are to be constructed in such positions that they can be emptied without the excreta or refuse being carried

through any dwelling house or public building or any building in which a person may be employed in any manufacture, trade, or business.

103. Every privy is to be provided with a sufficient opening for ventilation, as near to the top as practicable, and communicating directly with the open air. The floor of a privy is required to be paved with non-absorbent material, and is to be constructed so that it is, in every part, at least 6 inches above the level of the surface of the adjoining ground, and has a fall toward the door of at least $\frac{1}{2}$ inch in 1 foot. The floor under the seat of a privy must be at least 3 inches above the surface of the adjoining ground. If a movable receptacle is used, its cubic capacity must not exceed 2 cubic feet ; if a fixed receptacle is provided, it may be of any capacity not exceeding 8 cubic feet. The sides and bottom of a fixed receptacle, and the enclosing walls and floor of the space beneath the seat, in a case where a movable receptacle is used, must be constructed of non-absorbent materials.

104. An ash-pit provided in connection with a building must not in any case exceed 6 cubic feet in capacity. It may be either movable or fixed. In the former case, it must be constructed of galvanized iron or other suitable impervious material of sufficient strength and thickness, and must be provided with suitable handles and cover. In the latter case, the ash-pit must be constructed with stone flagging, slate, or brickwork at least 9 inches thick, properly rendered inside with cement or asphalted. The floor is to be raised at least 3 inches above the surface of the adjoining ground, and properly flagged and asphalted. The ash-pit is also required to be roofed over and ventilated and provided with a proper door. There is no doubt that a movable galvanized-iron ash-pit is a much more sanitary arrangement than a fixed ash-pit, and fixed ash-pits are not now recognized as satisfactory in some districts. A cesspool constructed in connection with a building must be formed of good brickwork built in cement mortar, and rendered on the inside in cement. The brickwork is required to have a backing of at least 9 inches of well-puddled clay or 6 inches of good cement concrete. The

cesspool is to be arched or otherwise properly covered over, and is to be provided with adequate means of ventilation. The requirement as to the provision of a backing to the brickwork is not included in many local by-laws.

MODEL BY-LAWS FOR RURAL DISTRICTS

COMPARISON WITH URBAN CODE

105. General Summary.—In considering the model code for rural districts, it must be remembered that rural districts are able, at their discretion, to frame much more extensive by-laws than those contained in the code. The Local Government Board, in a memorandum accompanying the printed draft of the rural model by-laws, state that they are not in a position to advise what, if any, by-laws are needed in particular rural districts, but that this responsibility rests with the local rural district council. The rural model by-laws deal with the questions of the structure of walls and foundations for purposes of health, the provision of air space about buildings, and the drainage and sanitation of buildings. Definitions of terms are also given, and there is a short list of buildings which are exempted from the operation of the by-laws. The rural code can be most easily dealt with by comparing it with the urban code. Some matters are dealt with very similarly in the two codes, and thus, when a fair idea of the urban requirements has been obtained, it is easy to become familiar with the rural code if the principal matters upon which it touches are remembered.

106. Definition of Terms and Buildings Exempted. — The terms public building, building of the warehouse class, domestic building, and dwelling house are given the same definitions as the urban code. The code also wholly exempts from its restrictions the buildings mentioned in Art. **61.** With such buildings are also included any building erected for use solely as a temporary hospital for the reception and treatment of persons suffering

from any dangerous infectious disorder, and any building which comes within the scope of the following clause :

Any building which shall not be a public building or a building of the warehouse class, and shall not be constructed or adapted to be used either wholly or partly for human habitation, or as a place of habitual employment for any person in any manufacture, trade, or business, and which, if intended for use as a pigsty or a cowhouse, shall be detached from any dwelling house.

107. Structural Requirements. — Those requirements of the rural code which have reference to the construction of buildings deal only with such matters of construction as affect the question of the health of the inmates. Where a new domestic building is erected, a layer of good cement concrete 6 inches thick must be provided over the site, whenever the dampness of the site or the nature of the soil renders such a precaution necessary. The walls of new public buildings and dwelling houses are required to have a proper damp-proof course of sheet lead, asphalt, or slates laid in cement or other durable material impervious to moisture. The damp-proof course is to be placed below the level of the lowest floor at a height of not less than 6 inches above the surface of the adjoining ground. Where any part of the lowest story of a building, other than a cellar, is carried below the level of the ground, the construction of hollow or other impervious walls and the provision of a double damp-proof course is required. The requirements for this construction are very similar to those in the urban model by-laws referred to in Arts. **69** and **72**. It should be noted, however, that, although the by-laws in the rural code which deal with the construction of hollow walls specify the width of the cavity as $2\frac{1}{2}$ inches, there is no requirement affecting the thickness of the brickwork. It would thus appear that the brickwork of each wall on either side of the cavity may be brick-on-edge, if such exceptionally economical construction is desired. Every wall of a new building when carried up above any roof, flat, or gutter so as to form a parapet is required to be properly coped or otherwise protected in order to prevent water from running down the sides of the parapet or soaking into the wall.

108. Requirements as to Open Space.—The requirements of the rural model by-laws with respect to air space in front of domestic

buildings are similar to those in the urban code which were referred to in Art. 85. The requirements as to air space at the rear of domestic buildings are somewhat more stringent than those in the urban code, for the minimum depth of the space at rear is 15 feet instead of 10 feet, and there are no special requirements applying to cases where buildings are re-erected, or where the site abuts on two streets. The complete requirements of the rural code as regards air space at the rear of domestic buildings are :

(1) Every person who shall erect a new domestic building shall provide in the rear of such building an open space exclusively belonging to such building, and of an aggregate extent of not less than *150 square feet*, and free from any erection thereon above the level of the ground, except a water-closet, earth-closet, or privy, and an ash-pit.

(2) He shall cause such open space to extend, laterally, throughout the entire width of such building, and he shall cause the distance across such open space from every part of such building to the boundary of any lands or premises immediately opposite or adjoining the site of such building to be *not less in any case than 15 feet*.

If the height of such building be *25 feet*, he shall cause such distance to be *20 feet* at the least.

If the height of such building be *35 feet* or exceed *35 feet*, he shall cause such distance to be *25 feet* at the least.

(3) A person who shall make any alteration in or addition to such building shall not, by such alteration or addition, diminish the aggregate extent of open space provided in pursuance of this by-law in connection with such building, or in any other respect fail to comply with any provision of this by-law.

(4) For the purposes of this by-law the height of such building shall be the height of the highest portion of the building, measured upwards from the level of the ground over which such open space shall extend to the level of half the vertical height of the roof or to the top of the parapet, whichever may be the higher.

109. Requirements as to Ventilation.—The requirements of the rural model by-laws with regard to the ventilation of floor timber are very similar to those of the urban code. A variation occurs, however, in consequence of the fact that the site need not in all cases be covered with a layer of concrete, although the provision of concrete is undoubtedly desirable in every case. Where concrete is omitted, the distance from the top of the ground to the under side of the floor timbers must not be less than

9 inches. The requirements for the ventilation of habitable rooms and public buildings are similar to those in the urban code, with the exception that the sectional area of the aperture or air-shaft required in the case of a habitable room without a fireplace is required to be only 50 square inches instead of 100 square inches.

110. Drainage and Sanitary Requirements.—The rural model by-laws differ but very slightly from the urban code as regards their treatment of the questions of drainage and sanitation. For all practical purposes, there is little need to do more than refer to the urban by-laws with regard to these questions, for the by-laws of each district vary considerably, and a study of either model code is of value only as giving a knowledge of what by-laws to expect. One of the principal points of difference between the two codes as regards matters of drainage and sanitation is that, in the rural by-laws, soil pipes are allowed to be $3\frac{1}{2}$ inches in diameter when they communicate with a 4-inch drain instead of 4 inches in diameter, as required by the urban by-laws. Another point of difference is that an earth-closet is not in any case allowed to be constructed within a building, as permitted by the urban by-laws, but must be placed at least 10 feet from a dwelling house or public building, or any building in which any person may be employed in any manufacture, trade, or business.

BUILDING WORK AFFECTED BY BUILDING LAW

POSITION OF ARCHITECT

111. Principal Points Affecting Architect.—Generally speaking, it may be said that in the case of the erection of ordinary domestic buildings on sites abutting on streets which have already been laid out, the architect need not pay much attention to the statute law, for his work will be almost exclusively governed by the provision of the local by-laws. With these, of course, he must be properly familiar. When, however, he undertakes the laying out of a building estate, or the construction of a building

of a special class such as a factory, or when, as is frequently the case in a well-qualified architect's work, he is called in to advise with regard to such matters as a private street apportionment of expenses, the responsibility for the repair of a defective length of pipe, the remedying of a building alleged to be dangerous, a knowledge of the statute law is most important. It is therefore necessary for an architect to familiarize himself with the principal points in the statute law which are likely to affect his work. The by-laws of a district in which work is being carried out should be read most carefully, and a copy of such by-laws always kept at hand for ready reference.

ERECTION OF BUILDINGS

112. Attention to be Paid to Law.—In the erection of buildings, it is necessary for the architect to have careful regard to the requirements of the statute law and by-laws in the preparation of his drawings and specification. When he has settled his design, it will be necessary to submit plans and particulars to the local authority. Such plans and particulars must be in sufficient detail to show that the proposed works conform to the by-laws. Although it is not necessary to obtain the permission of the local authority before actually commencing works, it is a safe practice, if time permits, to do so, for then there will be the satisfaction of knowing that no objection will be made to the arrangements and construction adopted. In the course of the erection of the building, it will be necessary to carry out the construction in accordance with the approved plans, and generally to comply with the building law. If, however, as very often happens, the architect is informed by the builder that the local officials require certain things to be done, he should make sure, before carrying out the required amendment of the construction, that it can correctly be required under the by-laws or some other portion of the building law. As the interpretation of by-laws depends, in the first place, on the individual views of the surveyor to the local authority, the architect may in some instances find that he unjustly is asked to take a course which may be detrimental to his building or a source of unnecessary expense.

Prog. No.....

TO THE CORPORATION OF THE CITY OF MANCHESTER.

I hereby give you Notice that it is my intention to erect certain Buildings in this City, and that the following particulars relate thereto, namely :—

No.	SUBJECT	PARTICULARS
1	Christian and Surname in *full*, Address, and Occupation of person for whom Buildings to be erected.	1 Henry James Robinson, Merchant 28 Earle Street - Manchester.
2	Name and Address of Architect.	2 John Jones. 28 Bride Street Manchester.
3	Description of Buildings and of the Materials to be used in construction of same.	3 Brick walls, with stone dressings to front Steel and concrete floors and roof
4	Situation of Buildings.	4 101 West New Street
5	Level or intended Level of Ground Floor, with reference to surface or Street.	5 Ground floor level to be six inches above finished pavement level at Entrance door
6	Intended use of Buildings.	6 Offices
7	Width of Streets or Open Space opposite Buildings.	7 Fifty feet
8	Size and Description of Drains.	8 4 inch and 6 inch best quality glazed stoneware
9	Inclination of Drains.	9 Not less than 1 in 40
10	Description of Outlet to Drains.	10 6" drain to sewer in West New Street
11	How supplied with Water.	11 From Corporations Supply mains
12	Description of Closet Accommodation.	12 Wash down water closets in positions shown on plans
13	Intended number of persons to be employed in Buildings to be used as Warehouses, &c.	13 ..... Males..... Females
14	Intended number of persons to be employed in Factory or Workshop.	14 .....

AND I herewith deliver at the Offices of your Architect complete Plans and Sections, *duly signed*, of every floor of such intended Building, drawn to a scale of not less than one inch to every eight feet, showing the position, form, and dimensions of the several parts of such Buildings, and of every Water Closet, Earth Closet, Privy, Ashpit, and all other Appurtenances; and also a Block Plan, drawn to a scale of not less than one inch to every forty-four feet, showing the position of the Buildings and Appurtenances of the Properties immediately adjoining, the width and level of the Street in front and at the sides, and of the Street or Passage at the rear of such Buildings, the level of the lowest floors of such Buildings, and of any Yards or Grounds belonging thereto. Such Plan also shows the intended lines of Drainage of such Buildings, and the intended size, depth, and inclination of each Drain, and the details of the arrangement proposed to be adopted for the Ventilation of the Drains.

Dated this 21st day of December. 1909

Signature in full, John Jones

Address, 28 Bride Street - Manchester

Occupation, Architect

N.B.—The attention of persons intending to build is particularly directed to the BYE-LAWS with respect to NEW STREETS and BUILDINGS, &c., and to the penalties for non-compliance with such Bye-Laws, which penalties will be strictly enforced.

NOTE.—This Notice, together with the Plans and Sections, to be left at the Office of the City Architect, Town Hall, Manchester.

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FIG. 1

113. Contractor's Responsibility.—Any encroachments on the pavement or roadway which are necessary for the erection of hoardings, gangways, or screens are under the control of the local authority. Application must be made for permission to construct them, and the necessary fees paid. The architect, however, does not do this, as it is the duty of the builder. All specifications should contain clauses binding the builder to make all such applications as may be necessary during the carrying out of the works, and to pay all fees. These applications are usually granted for a limited time only, so that, if undue delay takes place in the works, further applications may have to be made and more fees paid.

114. Notice Forms. — Most local authorities require the particulars accompanying plans submitted to be set forth on special forms which may be obtained from the local offices. These forms vary very much in character. Some authorities practically require the main details of the construction of the building to be described on the form; others adopt the more reasonable course of requiring only a few statements as to the situation and character of the work, and particulars of the drainage and water supply. Such forms, whatever their nature, must be filled in in a clear manner, with a view of giving the local authority, in as few words as possible, a knowledge of the work which it is proposed to carry out. As an example of such forms, the form issued by the Manchester Corporation is given in Fig. 1 by the courtesy of that authority.

EASEMENTS

NATURE AND ACQUISITION OF EASEMENTS

CHARACTER OF EASEMENTS

GENERAL PRINCIPLES

1. Meaning of Term Easement.—Every owner of property can exercise many rights in connection with his property without reference to the views of other persons. It is, however, recognized by English law that rights may in some instances be granted or otherwise acquired whereby an owner is compelled to allow certain conveniences to the owner of adjoining property or to refrain from doing certain things in connection with his property which might be harmful to the adjoining property. Where such a right is unconnected with the taking of anything from the adjoining land, but merely consists in the right of one owner to receive consideration from the owner of adjoining property, it is termed an **easement.** Where there is a right of access to adjoining land for the purpose of profit, as, for instance, a right to cut turf or dig sand, the right is not an easement, but is called a **profit à prendre.** Rights of the latter kind will not be dealt with in this Section.

2. Dominant and Servient Tenements.—An easement can be acquired only in connection with a **tenement,** which word is used in the law dealing with easements to denote a piece of land in one

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ownership, the question of whether or not the land is built on being immaterial as regards the application of the term. A right of way to be used by a person for all purposes is not an easement; a right of way is an easement only when it is granted in order to enable the person concerned to have access to his tenement over the tenement of another owner. Therefore, there are two tenements concerned in every easement: one that in respect of which the right is granted or acquired, and the other that over which the right extends. The former is called the **dominant tenement,** and the latter the **servient tenement.** The owners of the two tenements are often termed for the sake of brevity the *dominant owner* and the *servient owner.* Unless two tenements are concerned in this manner there can be no easement.

3. Common Forms of Easements.—The most important easements met with in architectural work are **easements of light.** It is hardly possible to erect a building in a crowded city neighbourhood without being forced to consider how the building may be arranged so as not to interfere with, in common language, *ancient lights*, or, more correctly, the rights of light possessed by adjoining owners. **Easements of air** are often met with at the same time as easements of light, as they also principally occur in crowded localities. **Easements of support** are also of considerable importance in building work, and may occur in connection with the support of a building by the adjoining soil or the support of one building by another. **Easements of way** and **easements of water** and **drainage** are met with, although the latter of these occurs principally in connection with engineering work. No easement of prospect is obtainable. An owner is not able to acquire an easement by which he can prevent an adjoining owner from building and obstructing his view.

4. Distinction Between Easements and Natural Rights.—It is well to realize that, as regards light, air, support, and water, there are natural rights which may be enjoyed by any property and which have not to be acquired as is the case with easements. These rights are, however, of a comparatively limited nature. The natural right as regards light is to receive it vertically; there is no right to receive light horizontally, without obstruction,

unless an easement is acquired, and the same applies with regard to air. As regards support, an owner of land has a natural right for his land to be supported by the adjoining land.

If the owners adjoining him excavate their soil up to the extreme limits of their boundaries and thus cause the subsidence of his land, he will have a good case for damages; but, unless he has acquired an easement, he can claim no right to any increased amount of support necessary to resist the weight of buildings placed on his soil. Every owner having land on the banks of a stream, other than an artificial stream, has a natural right to the use of the water, provided that he does not use it unfairly, having regard to the similar rights possessed by other owners of property on the banks of the stream. By means of the acquisition of an easement, it is, however, possible to interfere with the natural course of a stream, or to have a right to abstract an exceptional quantity of water. It will be seen that the rights obtained in the form of easements are much more comprehensive than natural rights, and in some cases are able to deprive an owner of some natural rights which he would otherwise possess.

5. Permanence an Essential Characteristic.—It is essential to the acquisition of an easement that the tenement in respect of which the easement is claimed has a permanent existence, and that the matters out of which the easement arises are also permanent, or, at least, may be continued at the option of the owner of the dominant tenement. Thus, it is not possible to obtain an easement of light in respect of a building which, from the character of the construction, is obviously for only temporary use. Nor is it possible to claim an easement to the use of an artificial stream owing its existence to some temporary cause, as, for instance, a stream formed of the waste water from a factory. Although in such a case the owner of the factory may have obtained an easement to discharge the water over certain land, the owner of the land will not have obtained an easement to compel the owner of the factory to continue the supply. These points must always be borne in mind when considering, in any case, whether or not an easement has been obtained.

6. **Transfer of Easements With Property.**—As easements are not personal rights, but rights acquired in respect of property, they pass with the transfer of the property. Thus, a person buying a servient tenement will be bound by the easement possessed over this tenement by the owner of the dominant tenement. In a similar way, a person purchasing a dominant tenement, unless words to the contrary are inserted in the document, termed the **conveyance,** by which the transfer of the property is effected, will become the possessor of all easements appertaining to such tenement. No owner is, however, entitled to impose any burden on the servient tenement that is greater than that formerly borne. A person, for instance, over whose land there is a right of way to a farm may successfully object to this right of way being used for the development of a building estate.

7. **Positive and Negative Easements.**—It is customary to consider easements as being divided into two classes, *positive,* or *affirmative, easements* and *negative easements.* A **positive easement** is one that gives the owner of the dominant tenement a right to do something affecting the servient tenement. Examples of positive easements are rights of way and rights to discharge water. A **negative easement** is one that enables the owner of the dominant tenement to prevent the owner of the servient tenement from doing certain otherwise lawful things on his own tenement. Examples of negative easements are rights of light and air, both of which apply only with regard to buildings. Another classification of easements is that of **continuous** and **discontinuous easements.** To the former class belong easements which are continual without any periodical act of man, an instance of which is an easement of light. A discontinuous easement is one the enjoyment of which can only be had by some act of man. An instance of this kind of easement is a right of way.

8. **Apparent and Non-Apparent Easements.**—A third classification of easements is that of dividing them into two groups of *apparent* and *non-apparent easements.* An **apparent easement** is one the existence of which is shown by some external thing affecting the servient tenement, as, for instance, a right to

discharge water, as indicated by a watercourse, or a right to light, as indicated by a window. A **non-apparent easement** is one of which there is no external evidence, such as an easement comprised in some legal document which prohibits the owner of the servient tenement from raising his building beyond a specified height.

9. Unity of Ownership.—When two properties are united in a single ownership, the arrangements of mutual interdependence by which the use of the two properties is facilitated are termed *quasi-easements*, that is, after the nature of easements, from the Latin word *quasi*, which means *as if*. The tenement in respect of which a quasi-easement is enjoyed is termed a *quasi-dominant tenement*, and that over which the easement extends, a *quasi-servient tenement*. When one or both of the properties are sold, the important question arises as to whether or not these quasi-easements are extinguished, or whether they pass with the property and become proper easements. The law on this subject is somewhat involved, and can best be dealt with when the question of the obtaining of easements by implied grant is considered. When two tenements formerly in separate ownerships become the property of one owner, all rights of easement are merged in the greater right of ownership. This has a very important influence on the question of the duration of time that an easement may legally be considered to be enjoyed.

If an easement in respect of a tenement is obtained over another tenement and the two tenements are united in a single ownership, then the easement is extinguished by the occurrence of the single ownership. Should the two tenements be again brought into separate ownerships, the duration of the easement, if such easement again comes into existence, will be reckoned from the day on which the dual ownership was resumed.

10. Law With Regard to Easements.—The greater part of the law with regard to easements is comprised in the common law. The judicial decisions, of which the common law affecting easements chiefly consists, extend as far back as mediaeval days, and no person can obtain an absolutely thorough knowledge of the law of easements without a careful study of the most important

of these decisions. The only Act of Parliament that affects the general law of easements is the Prescription Act, 1832. This Act was framed with the view of clearing up the difficulties that were found to exist in the way of obtaining rights by *prescription* at common law.

By prescription is meant a mode of acquiring rights by long-continued and uninterrupted enjoyment. The Prescription Act, however, is badly drafted, and it has been held that it does not override the old right to obtain an easement by prescription at common law. Consequently, instead of simplifying the law, the Act has, if anything, made it more complicated. It appears to be permissible to claim an easement by prescription either at common law or under the Prescription Act, or under both the common and the statute law.

ACQUISITION OF EASEMENTS

EASEMENTS BY GRANT, DIRECT OR IMPLIED

11. Origin of Easements.—Rights in the nature of easements between owners of adjoining property have been in existence from the early days of civilization. The subject of easements occupied an important position in Roman law. Probably, in the first instance, easements arose out of the natural disposition of property. The right of an owner of high-lying lands to discharge water indiscriminately over adjoining lands situated at a lower level, and thus practically to prevent their utilization, was doubtless, at an early date, curtailed ; but rights, acquired by custom, to discharge water over adjoining land were recognized and were probably the first forms of easement. In course of time, rights which had hitherto been acquired by custom were made the subjects of special grants ; these rights between owners of adjoining properties were extended to include other matters, and in this way the framework of the law of easements came to be formed.

12. Easements by Direct Grant.—Easements may be originated by Act of Parliament, but this course is seldom adopted.

The conferring of an easement by direct grant is a very common transaction in business dealings with regard to property. When an easement is to be conferred, a proper deed in due form must be drawn up by a solicitor and sealed and signed by the parties concerned. If this is not done, but merely an ordinary agreement prepared, the law apparently will not consider the transaction to be valid, although, after the lapse of years, it is probable that a Court of the Chancery Division, which deals with equity in contradistinction to law, would see fit to recognize the agreement as binding. Obviously, however, no risks of this kind should be run, but a solicitor should be instructed to prepare the necessary deed.

13. Easements by Implied Grant.—When a tenement in distinct and separate occupation is sold, any easements enjoyed in respect of the tenement pass, by implied grant, with the tenement to the purchaser. When, however, the tenement sold has previously been occupied in connection with another tenement belonging to the same owner, the question of whether or not the quasi-easements formed during the interdependence of the two tenements have any future existence is a matter of some little difficulty. In the first place it is necessary to distinguish between quasi-easements that are mere conveniences and those that are essential to the enjoyment of the property. These latter are termed **easements of necessity.** A quasi-easement of this kind invariably passes with the property irrespective of whether the quasi-dominant tenement in respect of which the quasi-easement is enjoyed is sold first, or whether the sale of this tenement takes place after the sale of the quasi-servient tenement, for when a property is sold the law implies a grant of such easements as are essential to the enjoyment of the property.

The distinction between an ordinary quasi-easement and one which on the severance of the two properties will become an easement of necessity is as follows: If a person owning two fields is accustomed, for the sake of convenience, to pass through one of them instead of using a means of approach that gives access to the field directly from the public way, the right of passing through the field is an ordinary quasi-easement. If,

however, there is no way of access to the second-mentioned field, except that of passing through the other field, the right of passage is an easement of necessity.

14. Future of Ordinary Quasi-Easements. — The continued existence or otherwise of quasi-easements that are not of such a character as to form easements of necessity depends in the first instance on whether or not the quasi-servient tenement is in the same ownership as the quasi-dominant tenement at the time of the sale of the latter. As soon as the quasi-servient tenement is sold, all quasi-easements extending over this tenement, other than easements of necessity, are extinguished. Consequently, if a tenement, at one time of a dominant character, is not sold until after the sale of the tenement over which its quasi-easements extended, there will be no quasi-easements to be considered, for these will have been extinguished on the sale of the quasi-servient tenement. When, however, the quasi-dominant tenement is the first to be sold, the law implies a grant to the purchaser of all continuous and apparent quasi-easements that are necessary to the reasonable enjoyment of the property.

This rule has been held to apply when both tenements are sold at the same time. The principle adopted by the Courts is that no man, having granted a tenement, may diminish the value of his own grant by withholding any easements that would be apparent from an inspection of the property. Generally speaking, therefore, it may be said that all ordinary quasi-easements of light, air, support, and water pass with the quasi-dominant tenement when, at the time of the sale of this tenement, the quasi-servient tenement is in the same ownership.

15. Implied Grant of Ways.—As rights of way are not, in the ordinary sense, apparent and continuous easements, it follows that rights of way enjoyed in respect of a quasi-dominant tenement, which are not ways of necessity, will not generally pass with the tenement when sold, unless special words to this effect are inserted in the conveyance. The Courts, however, have in some cases decided, where ways, though not essential, have been necessary to the reasonable and convenient enjoyment of the tenement, that there has been an implied grant of such ways.

In coming to such decisions, the Courts have also usually been influenced by the existence of some apparent sign, such as a doorway through which the way passes, or the fact that the roadway of the way is formed in a substantial and permanent manner, or some other thing that has enabled the right of way to be considered as being to some extent apparent.

EASEMENTS BY PRESCRIPTION

16. Acquisition by Prescription.—In considering whether an easement has been acquired by prescription, either at common law or under the Prescription Act, it is necessary to take note both of the manner in which it has been enjoyed and the length of time during which the enjoyment has continued. Unless the easement has been enjoyed in such a manner as to constitute, in effect, an assumption of the rights of ownership, no claim to it by prescription can be substantiated.

It will be a sufficient rebuttal of a claim for an easement by prescription to show that the easement has been enjoyed only by the periodic asking of permission. It is also necessary that the enjoyment shall have been continuous throughout the length of time on which the claim for the easement is based. By this it is not meant that cessation of use for an hour or a day at a time will invalidate the claim. If this were so, it would be practically impossible to substantiate a claim for an easement of a right of way. What is meant is a cessation of use of such a nature as to indicate the relinquishment of the claim to the easement. Obviously every case of this kind must be decided on its merits. The question of the length of time that an easement must have been enjoyed to render a claim for it valid must be considered in connection with whether the easement is claimed at common law or under the Prescription Act.

17. Prescription at Common Law. — At one time the law required, in theory, that for an easement to be acquired by prescription at common law it must be shown to have been enjoyed throughout the time of legal memory, a period which was fixed as extending back to A.D. 1189, the commencement of the

reign of Richard I. As time went on, the impossibility even of attempting to prove the existence of an easement to have extended to such a distant date became more and more apparent. Consequently, it became a custom for the Courts, in the absence of any evidence to the contrary, to assume that an easement which had been in existence for at least 20 years originally owed its inception to a grant which could no longer be traced.

At a later date this presumption of a lost grant became so well established as one of the recognized customs in dealing with a claim for an easement by prescription at common law that, where an easement could be shown to have been in existence for 20 years, juries were usually directed by the judges to find that a grant had been made although the weight of evidence might be of a contrary nature. Finally, in the case of *Dalton* v. *Angus*, which in 1881 was carried to the House of Lords, the highest Court of Appeal in English law, it was held that an easement of support, enjoyed for 27 years, could be successfully claimed although it was admitted at the trial that no grant had ever been made.

18. Easements Under Prescription Act.—The Prescription Act, 1832, originally applied only in England and Wales, but in 1859 it was extended to Ireland. It still has no application in Scotland. The first section of the Act deals with the obtaining of profits à prendre. The second section deals with the acquisition of easements, the provisions being as follows:

> And be it further enacted, that no claim which may be lawfully made at the common law, by custom, prescription, or grant, to any way or other easement, or to any watercourse, or the use of any water, to be enjoyed or derived upon, over, or from any land or water of our said lord the King, his heirs or successors, or being parcel of the Duchy of Lancaster, or of the Duchy of Cornwall, or being the property of any ecclesiastical or lay person, or body corporate, when such way or other matter as herein last before mentioned shall have been actually enjoyed by any person claiming right thereto without interruption for the full period of 20 years, shall be defeated or destroyed by showing only that such way or other matter was first enjoyed at any time prior to such period of 20 years, but nevertheless such claim may be defeated in any other way by which the same is now liable to be defeated; and where such way or other matter as herein last before mentioned shall have been so enjoyed as aforesaid for the full period of 40 years, the right thereto shall be deemed absolute

and indefeasible, unless it shall appear that the same was enjoyed by some consent or agreement expressly given or made for that purpose by deed or writing.

19. Application of Section 2 of Prescription Act.—It seems to be a matter of uncertainty whether the words "to any way or other easement" which occur in Section 2 of the Prescription Act are sufficient to bring easements of support within the scope of the section. The majority of the judges in the case of *Dalton* v. *Angus* were of opinion that easements of support could not be acquired under the Prescription Act. It appears that easements of air cannot be acquired under such Act. Easements of light are not included in Section 2, but are separately dealt with in Section 3. It will be seen that there are two periods of time mentioned in Section 2, namely, 20 years and 40 years.

Where an easement, other than an easement of light, has been enjoyed for a period of more than 20 years, but less than 40 years, it would seem that the only advantage gained in making a claim under the Prescription Act, instead of claiming by prescription at common law, is that the claim cannot be defeated merely by proving that the enjoyment commenced at a certain comparatively recent date, and that no grant of the easement was at any time made. Any other objection which would be admissible in opposing a claim to an easement by prescription at common law can presumably be made.

20. Easement of 40 Years' Duration.—When an easement has been enjoyed for 40 years, the only objections which can be advanced to a claim made under the Prescription Act are those having reference to questions of the rightfulness and character of the enjoyment. If it can be shown that the enjoyment in respect of the duration of which the easement is claimed originated at a time when it was contrary to law, the claim to the easement will fail. It obviously will also fail if proof is advanced that the enjoyment was held under a written consent or agreement.

21. Effect of Single Occupancy.—In considering the time during which an easement may be correctly said to have been

enjoyed, an important distinction has been made by the Courts between claims made under the Prescription Act and those made at common law. In the former case, it has been held by the Courts that if during any part of the time, whether exceeding 20 years or 40 years, the easement is alleged to have been enjoyed, the two tenements concerned have been in a single occupation, this is sufficient to break the continuity of the enjoyment and invalidate the claim, unless by any chance a sufficiently long period of enjoyment extending up to the date of the claim can still be shown unbroken by any unity of occupancy. This rule applies despite the fact that the tenements may have continued the whole of the time in separate ownerships. In the case of a claim made at common law, it is held that only by unity of ownership can the continuity of enjoyment be broken.

22. Section 3 of Prescription Act. — The question of the acquisition of rights of light under the Prescription Act is dealt with in Section 3, the provisions being as follows :

> And be it further enacted that when the access and use of light to and for any dwelling house, workshop, or other building shall have been actually enjoyed therewith for the full period of 20 years without interruption, the right thereto shall be deemed absolute and indefeasible, any local usage or custom to the contrary notwithstanding, unless it shall appear that the same was enjoyed by some consent or agreement expressly made or given for that purpose by deed or writing.

It will be seen that, for the acquisition of an easement of light by prescription under the Act, there is only one period, namely, of 20 years, in contradistinction to the two periods of, respectively, 20 years and 40 years, which apply in the case of easements of way and water. The enjoyment of access of light for 20 years gives similar rights of claim to an easement as does the enjoyment of a right of way or water for the full period of 40 years. It has been held that as the Crown is not mentioned in Section 3, it is not bound by the requirements of the section ; also, as it is not possible to obtain a right by prescription at common law against the Crown, no rights of light are obtainable over Crown property. This should not be lost sight of in practice.

23. Acquisition of Easement of Light by Tenant.—As it is essential that the access of light is enjoyed as an easement, an enjoyment of light while the two tenements concerned are in the same occupation will not give a right to light under the Prescription Act. It has been held that a right of light can be acquired by a tenant of a building over an adjoining building held by another tenant of the same landlord. When such a right has been acquired it operates against any owner of the servient tenement even though he be the common landlord of the two tenements.

The Crown, when acting as freeholders, and also the Ecclesiastical Commissioners, and many large landowners, make it a practice to insert in the leases of property a clause preventing the acquisition of an easement of light by one tenant against another. Any questions of light are required by the lease to be referred to the common landlord for settlement.

24. Legal Meaning of Interruption.—It is provided in Section 4 of the Prescription Act that in bringing an action to substantiate a claim to an easement the period to which the claim relates must be that immediately preceding the date of the action. This prevents an action from being brought under the Act in respect of an alleged easement the enjoyment of which has ceased before the bringing of the action. The most noteworthy provision in the section is, however, that which concerns the question of the **interruption of an easement.** It is provided that no act or other matter is to be deemed an interruption within the meaning of the Act unless the same has been submitted to or acquiesced in for 1 year after the person interrupted has received notice of the interruption from the person making or causing the same to be made.

One of the results of this provision is, in effect, to reduce each of the minimum specified periods of enjoyment required for obtaining an easement by the extent of 1 year less 1 day. Thus, for instance, the minimum period for the acquisition of a right of light is usually stated to be 20 years; but actually it is 19 years and 1 day, because once a person has enjoyed a right of light for this period it will not be possible for the owner of the servient

tenement to effect a proper interruption within the meaning of the Act, for before the year required for an interruption will have elapsed the dominant owner will have obtained the 20-year enjoyment specified by the Act.

25. Calculation of Periods of Enjoyment.—Sections 7 and 8 of the Act deal with the calculation of the periods of enjoyment, and allow for the omission of time from the calculations under certain circumstances. Section 7 provides that, in the case of a claim, based on a 20-year enjoyment, for an easement other than an easement of light, any time during which the person otherwise able to have resisted the enjoyment shall have been under 21 years of age, or of unsound mind, or otherwise incapable of legal resistance, is to be excluded from the computation of the 20 years. The section also provides that in the case of any such claim the time during which any action at law, subsequently abated by the death of one of the parties, was pending is to be excluded from the computation.

26. Claims Based on 40-Year Enjoyment.—Section 8 deals with cases where claims are based on a 40-year enjoyment, and provides that when any land or water, on, over, or from which any such way or other convenient watercourse is enjoyed, has been held for life or for a term not less than 3 years, the time of such enjoyment is to be deducted in the computation of the 40 years. This concession, however, only applies when the owner of the servient tenement contests the claim for the easement within 3 years after the expiration of the lease.

The object of this provision is to prevent the acquisition of an easement over a tenement at a time when, the tenement being let on lease, the owner is unable to protect his interests. It will be noted that the section ostensibly applies only as regards a right enjoyed in respect of "a way or other convenient watercourse," but it is generally believed that in the drafting of the Act a mistake in copying was made and the word "convenient" inserted instead of "easement." As no case has been contested with regard to this point it is uncertain whether the section is to be taken as having a restricted application, or whether it is to apply to all easements coming within the scope of Section 2,

27. Essential Qualities of Enjoyment. — There are certain characteristics of enjoyment, without which the mere fact of enjoyment for a period of time will not confer a right to claim an easement. These characteristics are very pertinently summarized in a sentence from the Roman law, which is to the effect that the enjoyment must not be by force, nor secretly, nor by permission. Proof of acts of opposition on the part of the owner of the servient tenement, on account of which the enjoyment of the alleged easement could only be had by force, will be sufficient to destroy a claim for an easement. The enjoyment must also be open, or otherwise no easement will result. An instance of this is the case of a house which, through exceptionally bad construction, requires to be held in position by the wall of an adjoining house. As the enjoyment of this exceptional support is without the knowledge of the owner of the house that affords such exceptional support no easement can be claimed.

28. Effect of Enjoyment by Permission. — The question of enjoyment by permission assumes a somewhat different aspect according to whether an easement is claimed at common law or under the Prescription Act. At common law any admission, whether verbal or in writing, to the effect that the enjoyment is by permission of the owner of the servient tenement will be sufficient to prevent an easement from being obtained.

The Prescription Act makes a distinction between a claim for an ordinary easement on the basis of a 20-year enjoyment and a claim based on a 20-year enjoyment in the case of light, or a 40-year enjoyment in other cases. As regards a claim of the first-mentioned kind, the case is apparently to be judged on similar lines to a claim at common law, any admission as to the enjoyment having been by consent being sufficient to invalidate the claim. As regards a claim of the second kind, it is necessary, in order to refute the claim, that the consent or agreement shall have been made by deed or in writing. This distinction is evident from a perusal of Sections 2 and 3 of the Act.

29. Means to be Taken to Prevent Acquisition.—As it is very possible that the enjoyment of a right for 20 years will be sufficient to enable an easement to be acquired, it is necessary to

consider the proper course of action to be taken by an owner of premises over which an easement is in course of being acquired. The acquisition of affirmative easements, such as rights of way, may be prevented by means of an action at law against the person committing the trespass or other act. In the case of negative easements, such as those of light and air, the remedy against the acquisition of such easements lies in the erection of an obstruction, such as a screen, to prevent the rights of light or air from being enjoyed. This, of course, must be erected on the land over which the easement is being acquired.

It should be noted that an obstruction, to be an interruption within the meaning of the Prescription Act, must remain in existence for at least a year. As regards the acquisition of an easement of support, it would appear from the case of *Dalton* v. *Angus* that the only remedy of an owner of land over which a right of support is being acquired by the erection of a heavy building on adjoining land is that of excavating his own land and letting down the adjoining building. Obviously, however, such an extraordinary proceeding will hardly ever be adopted. The prevention of the acquisition of easements of support being most exceptional, it follows that these easements are of general occurrence in closely built areas. It is therefore generally assumed that land surrounded by buildings is subject to easements of support, and retaining walls are provided where necessary to resist the thrust due to the weight of adjoining buildings.

30. Common Method of Preventing Acquisition.—In addition to the previously mentioned methods of preventing the acquisition of an easement, there is one, applicable to all cases, which is very frequently adopted. This consists in arranging that the right desired is to be obtained only by licence given by the owner of the other tenement. Often a nominal rent is charged. In transactions of this kind it is most desirable that the necessary documents should be prepared by a solicitor, as legal technicalities are involved, and it may thus happen, if the transaction is carried through without the advice of a lawyer, that the interests of the person granting the licence may not be properly safeguarded.

EXTINGUISHMENT OF EASEMENTS

EXPRESS OR IMPLIED RENUNCIATION

31. Methods of Extinguishment.—Easements may be extinguished by means very similar to those by which they may be acquired. They may be expressly extinguished by Act of Parliament or renounced by the persons possessed of them, and may be extinguished by the union of the two tenements concerned or by the abandonment of use. An easement of necessity, also, is extinguished immediately that, by the purchase of other property or by some other means, it is rendered no longer essential to the enjoyment of the property. As an easement of this kind has arisen because of a necessity, its enjoyment endures only as long as the necessity continues. Any express renouncement of an easement must be by means of a proper deed prepared by a solicitor, but where an ordinary agreement has been given and acted on for several years, it is probable that a court of equity would recognize the transaction as legal.

32. Extinguishment by Implied Renunciation.—Just as difficulties arise in deciding whether or not an easement has been obtained by use for a certain length of time, so also it is often difficult to ascertain whether an easement has been extinguished by cessation of enjoyment. Generally speaking, it may be said that the law does not require such a great weight of evidence to be advanced for the proof of the extinguishment of an easement as it does in the case of an action for the acquisition of an easement, but a reasonable amount of evidence is, of course, required. A permanent alteration of the dominant tenement, if of such a nature that it makes the tenement incapable of enjoying an easement that may appertain to it, will have effect in extinguishing the easement. An instance of this is the permanent bricking up of a window in respect of which a right of light is enjoyed.

33. Question of Re-erection of Building. — One of the most obvious questions to be raised as regards the extinguishment or continuance of an easement is that of the re-erection of a building

and the effect of this action on any easements enjoyed with the building. It is certain, from a perusal of the decided cases on this subject, that, if the acts of demolition and reconstruction follow immediately one on the other, all easements enjoyed in respect of the old building will be enjoyed in respect of the new one, so long as no additional burden is imposed on the servient tenement and the new building follows the same lines as the old. Should, however, an additional burden be imposed, it is probable that the right of easement would be held by a court of law to be suspended, if not destroyed altogether. Points of difficulty occur when the re-erection does not immediately follow the demolition of the building, or when the new building is so constructed that the easement cannot be enjoyed in the same manner as before.

As regards the first, there is no time specified after which the easements held in respect of a building that has been demolished, but not re-erected, will be considered to have lapsed. Each question must be decided on its merits. One of the vital points which will affect the decision in a case of this kind is that of whether the owner of the dominant tenement has indicated in any way his intention to resume the enjoyment of the easements possessed in respect of the demolished building. If he has thus indicated his intention, it would appear that he may maintain his rights for many years.

34. Loss of Easement in Reconstruction.—As regards the question of the reconstruction of a building in such a way that an easement cannot be enjoyed in the same manner as before, it may happen in such cases that the easement will be extinguished. If, for instance, a building formerly having a right of support from an adjoining building is so reconstructed that it no longer avails itself of the support, the easement will lapse. In a similar way, if a building having a right of light is so constructed that no windows coincide in position with any parts of the previous windows, the right will be extinguished.

35. Extinguishment of Rights of Way and Water.—As rights of way and rights to the use of water are discontinuous easements, it is more difficult to determine when a cessation of use has taken place than in the case of continuous easements of

light and support. The law also appears to permit of a very considerable period of cessation of use before it will consider an easement of this kind to have been extinguished. On the strength of the fact that an enjoyment of at least 20 years is required to enable a claim to an easement to be made by prescription, judges have expressed the opinion that a cessation of use for 20 years is required to constitute an extinguishment of an easement of this kind. Cases have also occurred where, although rights of easement have not been made use of for much longer periods than 20 years, the Courts have held that there has been no abandonment. It appears, however, to be impossible to lay down any general rules in regard to this matter; each case must be considered on its merits.

EXTINGUISHMENT BY ACT OF SERVIENT OWNER

36. Loss of Rights by Dominant Owner.—It is evident that if the owner of the dominant tenement does not take care to protect his interests when threatened by some act of the owner of the servient tenement, he may lose the easement of which he, in respect of his tenement, is possessed. An instance of this kind occurs when an owner of a tenement that has rights of light over another tenement allows the owner of this latter servient tenement to build so as to obstruct his rights of light, and allows the obstructive building to continue in this position for a year. At the end of the year an interruption within the meaning of the Prescription Act will have taken place and the easement will be at least partly extinguished. A similar result will occur when the use of an easement of way is obstructed for a period of a year by the servient owner, and the dominant owner acquiesces in or submits to the obstruction.

37. Methods of Preventing Loss of Rights.—In all cases where the owner of the dominant tenement desires to prevent his rights from being destroyed by an action of the owner of the servient tenement, his remedy consists in taking legal proceedings. If the works proposed by the owner of the servient tenement are such that it can be proved that they will most seriously affect the convenient use of the dominant tenement,

it is almost certain that an injunction will be granted by the Court. This injunction will prohibit the work from being further proceeded with. If, however, the case is not of such a serious character, it is probable that the Court, if approached to that effect, will not grant an injunction, but will consider that the circumstances do not warrant anything more than an action for damages.

VARIOUS KINDS OF EASEMENTS

EASEMENTS OF LIGHT

LAW AS TO AMOUNT OF LIGHT ACQUIRED

38. Easements of Light Obtainable for Buildings Only.—Section 3 of the Prescription Act deals exclusively with rights of light enjoyed by any dwelling house, workshop, or other building, and thus it is clear that, under the Act, no successful claim can be made for an easement of light other than in connection with a building. It has also been held, in a case where the claim to the easement was made at common law, that no right of light could be claimed in respect of a timber-yard and a saw-pit. Thus it seems evident that, from whatever point the question is considered, no rights of light can be obtained except in respect of a building.

39. Extent of Light Obtained by Easement.—Ever since easements of light came to be recognized by law there has been much controversy as to the extent of light that it is possible to obtain by easement. The importance of the question can hardly be overestimated. Obviously, if it were possible to claim that the light acquired by a building should not be in any respects diminished, the erection of a building on town sites previously unoccupied would be practically an impossibility. This point has always been recognized by the law, although until comparatively recently there was much uncertainty as to the extent to which the light acquired by an easement may be diminished.

40. 45° Angle of Light.—At one time it was considered that the light to windows having easements of light could be diminished to the extent of an angle of 45° with the horizontal, measured from the sill of the lowermost window, but that no greater diminution of light was in any case permissible. This is illustrated in Fig. 1, in which *A* is the building having rights of light and *B* is the building required to be erected so as not materially to interfere with the rights of light possessed by *A*. The building *B* is shown to be erected so as to diminish the rights of light to the extent of an angle of 45°. The 45° angle of light is, however, no longer accepted as a binding rule, but it is most useful as a test, for if the light received by a window is not obstructed to a greater extent than 45°, it may be taken in almost every case that sufficient light is provided.

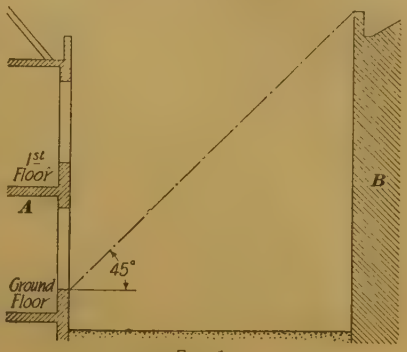

FIG. 1

41. Case of Colls *v.* Home and Colonial Stores, Ltd.—The uncertainty as to the amount of light that can be claimed by a tenement having an easement of light has been to a large extent dispelled by the case of *Colls* v. *Home and Colonial Stores, Ltd.*, which in 1904 went to the House of Lords. The circumstances of the case were as follows: The Home and Colonial Stores occupied premises on the north side of Worship Street, in the City of London, which were used by them as offices for a large staff of clerks. In front of their premises, and on the opposite side of the street, was a low building the front portion of which had a height of only 19 feet 6 inches to the top of the parapet.

The width of Worship Street between the two buildings was approximately 41 feet. The low building was acquired by Colls, one of the parties to the case, and he proposed to pull down the building and erect in its place a new building having a height of 42 feet. The Home and Colonial Stores objected to the erection

of this building on the ground that it would materially reduce the light to their premises, which had been in existence for more than 20 years, and they applied to the High Court for an injunction to restrain Colls from erecting the proposed building.

42. Angles of Light in Colls's Case.—The relative positions of the two premises are shown in Fig. 2, in which the premises

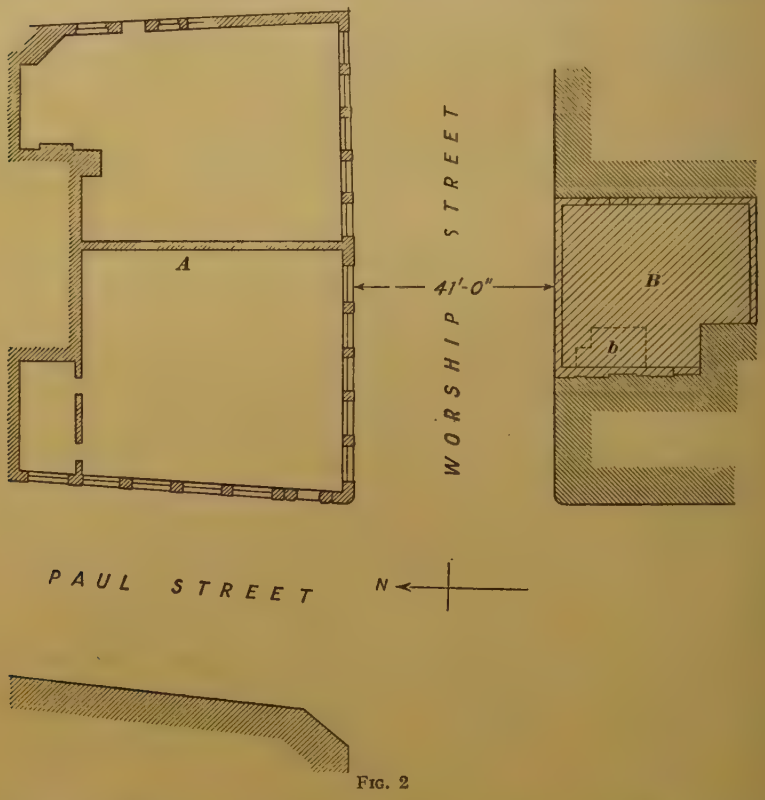

FIG. 2

occupied by the Home and Colonial Stores are indicated at *A*, and the building as proposed and subsequently erected by Colls is indicated at *B*. The stairs providing means of escape, which are carried up above the roof, are shown dotted on the plan at *b*. The angles of light provided to the first-floor and ground-floor windows are shown in Fig. 3 (*a*), (*b*), and (*c*), the portion of the new building rising above the old building is denoted by light

hatching, and the 45° angle of light is shown by a dot-and-dash line. It will be seen from (*a*) that, with the new building carried up to a height of 42 feet, the unobstructed angle of light at a level midway between the sills and heads of the first-floor windows is 65°, this being 14° less than the angle of light enjoyed during

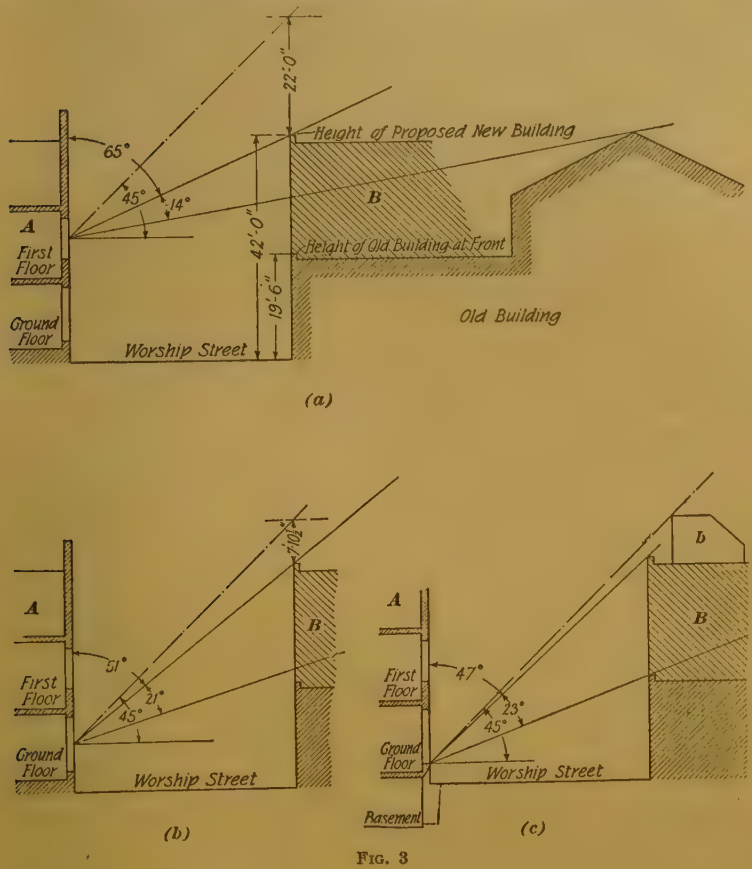

FIG. 3

the existence of the old building. The inclined line denoting the angle of light is in the case of the old building drawn from the apex of the roof of the back portion of the building. It will be seen that, on the basis of providing only a 45° angle of light to the first-floor windows, the new building could be erected to a height exceeding by 22 feet the height proposed.

43. Lines of Angles of Light.—In Fig. 3 (*b*) are shown the angles of light provided at a level midway between the sills and heads of the ground-floor windows. With the new building erected to a height of 42 feet, the unobstructed angle of light is 51°, which is 21° less than the angle provided during the existence of the old building. The line denoting the angle of light is in this case, as in (*a*), drawn from the apex of the roof of the back portion of the old building, but such portion is not in this case shown. On the basis of providing only a 45° angle of light to the ground-floor windows, the building could be erected to a height exceeding by 7 feet 10½ inches the height of 42 feet proposed. In (*c*) are shown the angles of light provided at the sills of the ground-floor windows. With the new building erected to a height of 42 feet, the unobstructed angle of light is 47°, which is 23° less than the angle of light provided during the existence of the old building. The line denoting the 45° angle of light just touches the external angle of the enclosure to the escape stairs *b*, which is in this case shown in the section.

44. Decision of Courts in Colls's Case.—At the hearing of the case in the High Court it was stated, on behalf of the Home and Colonial Stores, that they required more than ordinary light for the purpose of carrying on their clerical work, and it was claimed that they were entitled to the amount of light that they had hitherto enjoyed. The judge, however, held that after the erection of Colls's building, the premises of the Home and Colonial Stores would be well and sufficiently lighted for all ordinary purposes of occupancy as a place of business, and that more than this could not be legally claimed. The case was therefore given against the Home and Colonial Stores, and the granting of an injunction was refused. The case was, however, taken to the Court of Appeal, who reversed the decision of the High Court, Colls having meanwhile proceeded with and completed the erection of his building. The Court of Appeal were of opinion that the erection of Colls's building resulted in substantial interference with the light enjoyed by the Home and Colonial Stores. An injunction was therefore granted requiring Colls to pull down the offending portion of his building.

45. Decision of House of Lords in Colls's Case.—On appeal being made to the House of Lords, the decision of the High Court was upheld and that of the Court of Appeal reversed. The Lord Chancellor pointed out that if it were the law that an enjoyment of light for 20 years conferred a right to the enjoyment of the whole of the light without diminution, it would be almost impossible for towns to grow, and the rights of people to utilize their own land would be greatly restricted. This, however, was not the law. In his opinion the test to be applied was whether the obstruction to light that was complained of was a nuisance, a test that would make the amount of light acquired depend on the surroundings and on the light coming from other sources, as well as the proximity of the building causing the obstruction.

46. Summary of Law in Relation to Light.—All the law lords before whom the Colls case was tried gave their judgments on the case. The pronouncement made by Lord Lindley is specially noteworthy as constituting an authoritative summary of the law relating to light. This pronouncement, with all such legal references and remarks as are not essential to the explanation of the law eliminated, is as follows:

The language of Section 3 of the Prescription Act, 1832, shows that in order to acquire a right to light there must be: First, access and use of light, not access alone. Access is here understood to refer to free passage of light over the servient tenement. Secondly, such access and use must be to and for some dwelling house, workshop, or other building. Thirdly, such access and use must be actually enjoyed therewith. Fourthly, such enjoyment must be without interruption for 20 years. Fifthly, if all these are proved, the right to the access and use of light so enjoyed becomes absolute and indefeasible, unless it can be explained by some deed or writing. Pausing here for a moment, it will be observed that the statute does not in terms confer a right to light, but rather assumes its acquisition by use and enjoyment, and declares it to be "absolute and indefeasible."

Again, it will be observed that nothing is said about enjoyment as of right; and notwithstanding Section 5 of the Act, which refers to enjoyment as of right, it was early decided that, as regards light claimed under Section 3, enjoyment as of right need not be alleged or proved; and that the right, whatever it may be, is acquired by 20 years' use and enjoyment without interruption and without written consent. This was not so under the old law. As regards use and enjoyment, there are some

instructive decisions on unfinished and uninhabited houses, and on windows kept closed by shutters. These decisions show that a right of light may be acquired in respect of a house which has stood for 20 years without being occupied or even finished so as to be fit for occupation, and that the fact that shutters have been closed for some months at a time does not prevent the acquisition of a right to light through the windows.

These decisions did not, however, turn upon or settle with any precision the amount of light to which a right is acquired by 20 years' user. Nor is the statute clear upon this point. At one time it appears to have been considered that in all cases the size and situation of the aperture through which light had come for 20 years formed both the maximum and minimum measures of the right acquired, without reference to the use and enjoyment of the light which had so come. But this view was emphatically negatived by the Court of Appeal in Chancery in *Kelk* v. *Pearson*. This case shows that in ordinary cases a person does not necessarily acquire a right to all the light which he has had for 20 years. He may have had more than was reasonably required either for domestic or business purposes, and in that case his right is limited to the amount of light reasonably required.

The doctrine laid down in *Back* v. *Stacey*, as I understand it, is the same as that laid down, although in somewhat different language, by the Court of Appeal in *Kelk* v. *Pearson* and *City of London Brewery Company* v. *Tennant*, and must, I think, be taken as finally established and as good sound law. That doctrine, as stated in *City of London Brewery Company* v. *Tennant*, is that, generally speaking, an owner of ancient lights is entitled to sufficient light according to the ordinary notions of mankind for the comfortable use and enjoyment of his house as a dwelling house, if it is a dwelling house, or for the beneficial use and occupation of the house, if it is a warehouse, a shop, or other place of business. The expressions "the ordinary notions of mankind," "comfortable use and enjoyment," and "beneficial use and occupation," introduce elements of uncertainty; but similar uncertainty has always existed, and exists still, in all cases of nuisance, and in this country an obstruction of light has commonly been regarded as a nuisance, although the right to light has been regarded as a peculiar kind of easement.

If a more absolute standard had been adopted in all cases, certainty would no doubt have been gained; but the consequences would frequently have been very oppressive on the owner of the servient tenement, and far more so than under the old law. The owner of the servient tenement could have done nothing on his own land, which in fact diminished the light acquired by his neighbour, even if all of it was not wanted for comfortable enjoyment or business purposes. It would follow that the owner of a piece of vacant land opposite to a house in an ordinary street could not build upon it at all after 20 years. The adherence to the old but uncertain standard of comfort and convenience avoids the danger of

oppression and extortion, and renders it necessary to take a wider view of each case, especially when an injunction is asked for.

The decision in *Kelk* v. *Pearson* has a far-reaching effect. If there is no absolute right to all the light which comes to a given window, no action will lie for the obstruction of that light unless the obstruction amounts to a nuisance. If there is no right of action, *a fortiori* * there is no right to an injunction to prevent a permanent diminution of light unless it amounts to a nuisance. But, in considering what is an actionable nuisance, regard is had not to special circumstances which cause something to be an annoyance to a particular person, but to the habits and requirements of ordinary people, and it is by no means to be taken for granted that a person who wants an extraordinary amount of light for a particular business can maintain an action for diminution of light if only his special requirements are interfered with. The expression "right to light" is sanctioned by the Prescription Act, and is convenient; but its use is apt to lead to error and to forgetfulness of the burden thrown on the servient tenement. This burden, however, ought never to be lost sight of in considering the extent of the right claimed in respect of the dominant tenement. But the adoption of the more flexible standard of comfort and convenience has introduced difficulties of a serious nature, especially when dealing with places of business; and it is not surprising that different views on this subject should have been taken, and that the decisions upon it should be inconsistent with each other.

In applying the rule laid down in *Kelk* v. *Pearson* it is impossible to avoid considering how much light is left and where it comes from. But the question to be decided is not how much light is left, but whether the plaintiff or dominant owner has been deprived of so much as to constitute an actionable nuisance. If he has, it is no defence to say that he has as much light left as most other people. There is no rule of law that if a person has 45° of unobstructed light through a particular window left to him he cannot maintain an action for a nuisance caused by diminishing the light which formerly came through that window. But experience shows that it is, generally speaking, a fair working rule to consider that no substantial injury is done to him where an angle of 45° is left to him, especially if there is good light from other directions as well. As regards light from other quarters, such light cannot be disregarded; for the light from other quarters and the light the obstruction of which is complained of may be so much in excess of what is protected by law as to render the interference complained of non-actionable. I apprehend, however, that light to which a right has not been acquired by grant or prescription, and of which the plaintiff may be deprived at any time, ought not to be taken into account.

The purpose for which a person may desire to use a particular room or building in future does not either enlarge or diminish the easement which

* With a stronger reason.

he has acquired. If he chooses in future to use a well-lighted room or building for a lumber room, for which little light is required, he does not lose his right to use the same room or building for some other purpose for which more light is required. But if a room or building has been so built as to be badly lighted, the owner or occupier cannot, by enlarging the windows or altering the purpose for which he uses it increase the burden on the servient tenement.

The result of the foregoing review of the authorities is not altogether satisfactory. The general principle deducible from them appears to be that the right to light is in truth no more than a right to be protected against a particular form of nuisance, and that an action for the obstruction of light which has in fact been used and enjoyed for 20 years without interruption or written consent, cannot be sustained unless the obstruction amounts to an actionable nuisance; and this often depends upon considerations wider than facts applicable to the complainant himself.

There are elements of uncertainty which render it impossible to lay down any definite rule applicable to all cases. First, there is the uncertainty as to what amount of obstruction constitutes an actionable nuisance; and second, there is the uncertainty as to whether the proper remedy is an injunction or damages. But notwithstanding these elements of uncertainty, the good sense of judges and juries may be relied upon for adequately protecting rights to light on the one hand, and freedom from unnecessary burdens on the other. There must be consideration for both sides in all these controversies.

This is the judgment of a celebrated lawyer, and every sentence of it is worth reading and considering with the greatest care. The old law to which allusion is made in one or two instances is the law existing prior to the commencement of the Prescription Act, 1832.

47. Buildings Occupied for Special Purposes.—The general result of the case of *Colls* v. *Home and Colonial Stores* is the formulation of the rule that legal action can be successfully taken in respect of the obstruction of an easement of light only when the obstruction amounts to a nuisance. As the general law with regard to nuisances does not entitle a person in bad health, or who carries on a delicate trade, to greater freedom from annoyance than ordinary persons, it follows that a person conducting a business for which an extraordinary amount of light is required and enjoyed cannot claim a right to such extraordinary enjoyment. It appears that, in considering the amount of light which the owner of the dominant tenement is entitled to claim by

prescription, the purpose for which he uses the light should be disregarded, as it does not affect the easement which he has acquired. This appears to have been definitely settled in cases which have been decided since the decision in *Colls* v. *Home and Colonial Stores*.

48. Effect of Colls's Case on Alterations. — An analysis of the effect of the decision in the Colls case shows that the law as regards the burden imposed on the servient tenement, as measured by the size of the windows, has been entirely reversed. Previous to this decision it was considered that the enlargement of a window having a right of light would result in an increased burden being imposed on the servient tenement. This is stated in Lord Lindley's judgment, quoted in Art. **46.** Since, however, it is now the law that an obstruction to a right of light is to be considered simply on the basis of nuisance or no nuisance, it is evident that an increase in the size of a window will be to the advantage of the servient tenement.

It may happen that an obstruction which would have formed a just cause for a successful action in the case of the old window, may not, in consequence of the increased size of the window, reduce the light to such an extent as to be a nuisance. On the other hand, a decrease in the size of a window having rights of light will impose an increased burden on the servient tenement; for the erection of a wall or building which would not have injuriously affected the light prior to the alteration may, in consequence of the reduction in size of the window, result in reducing the already lessened amount of light to such an extent as to be a nuisance.

In the case of *Ankerson* v. *Connelly*, heard in 1906, it was held that the owner of a dominant tenement, who in reconstructing his building had excluded a large amount of light, had imposed an increased burden on the servient tenement and had consequently lost his rights of light over such tenement. This somewhat curious result of the decision in *Colls* v. *Home and Colonial Stores* should not be lost sight of when premises are being rebuilt. Although it is recognized by the best legal authorities, it does not yet seem to be appreciated by architects.

PRACTICE IN ANCIENT-LIGHT CASES

49. Position of Architect.—In considering the position of the architect in regard to ancient-light cases, it is essential to realize that his course of action is entirely regulated by whether he is acting for the owner of a dominant or of a servient tenement. If he is required to erect a building on a site previously unbuilt on, and over which the owner of an adjoining tenement has rights of light, he of course acts for the owner of a servient tenement. When, as is often the case, he is required to re-erect a building having right of lights over an adjoining building, and being also subject to rights of light from the same or another adjoining building, his duties are of a dual character.

The tenement on which he is required to re-erect a building is dominant as regards its own rights of light, and servient as regards the rights of light of the adjoining building or buildings. An architect also may be engaged in another capacity than that of the designer of a building. An owner of a dominant tenement usually engages an architect or surveyor to advise as to the steps to be taken to protect his interests in a case where his rights of light are threatened by the action of the owner of the servient tenement.

50. Erection of New Building.—In the case of the erection of a building on unoccupied land over which there are rights of light, the architect will be bound in the preparation of his design to pay a great deal of attention to these rights, when, by means of careful inquiries, he has made certain that the windows in respect of which the rights of light are claimed have been in existence for the required 19 years and 1 day. Often he will be compelled to leave a very considerable portion of his site unbuilt on in order to afford light to the ancient windows of adjoining buildings. Occasionally, in the case of a very confined site, it may happen that the rights of adjoining owners are such that, if enforced, they will practically preclude the erection of any building.

In a case of this kind, however, and also in other cases where the rights of light, though not so restrictive in effect, yet greatly

hinder the profitable utilization of the site, much may be done in the way of arrangement with adjoining owners. If, in a difficult case of this nature, the architect's client is prepared to go to some little expense in the way of making arrangements with, or paying compensation to, adjoining owners having rights of light, the site may be utilized with satisfaction to all parties. It is very desirable that any agreements entered into should either be prepared or examined by a solicitor acting on behalf of the building owner.

It is often possible to minimize to some little extent the effect of the erection of the building on the light received by adjoining buildings. A common practice is to face all walls opposite to windows of adjoining property with white glazed bricks. Sometimes, where an arrangement is being made with the adjoining dominant owner, a part of the agreement will be that reflectors or prismatic glass are to be provided to all his windows that will be darkened by the erection of the proposed building.

51. Re-erection of Building.—Before a building in respect of which there are rights of light is commenced to be pulled down, preparatory to re-erection, the architect should have careful drawings of the old building prepared, with the position and sizes of all the windows fixed by dimensions. Then, when the plans of the new building are being prepared, the new windows, as far as possible, having regard to the proper lighting of the rooms, should be arranged to coincide in position with the previously existing windows.

From the practical standpoint, it will not matter much in ordinary cases if the new windows are a little wider or higher than the old windows ; for, although the owner of the servient tenement has a right to obstruct the light received by the additional amount of window space provided, he has no right to obstruct the light received by the portions of the new windows that coincide in position with the old windows. Unless the windows are in a wall immediately on the boundary line between the tenements, it is not usually possible for the owner of the servient tenement to obstruct the light coming to the new window space without interfering with the light received by the old

window space. Further, as the decision in *Colls* v. *Home and Colonial Stores* makes an increase in the window space have the effect of decreasing the burden imposed on the servient tenement, it would appear that when this fact is more fully realized such an increase will be welcomed, instead of being objected to, by the servient owner. Windows should not be reduced in size.

52. Arranging New Windows.—In arranging the new windows care should be taken not to depart to any great extent from the original arrangement of window space, for if the new scheme of arrangement differs very much from the old, there will be a risk of losing the rights of light. Also, if the new building is not erected immediately after the old one is taken down, the architect should indicate on the site, by notice boards or some other suitable means, the position of the windows having rights of light.

Where the old building was not only possessed of, but subject to, rights of light, it will often happen that the rights of light possessed by adjoining owners will prevent a desired increase in height of the new building. In such a case, the owners of both properties being possessed of rights of light, a give-and-take arrangement may often be made, whereby the new building is carried up to the desired height, and the owner of the adjoining building given an agreement that permits him to make some desired alterations and additions to his building at some future time.

53. Architect Acting for Dominant Owner.—The position of the architect when erecting a new building and when re-erecting an existing building having been considered, there yet remains the case when he acts in opposition to the building owner, that is to say, when he is called in by an owner of a dominant tenement who thinks that his rights of light are threatened by some proposed building operations on the land of the servient owner. The first steps that should be taken by an architect in a case of this kind are the making of inquiries as to which windows are considered to have rights of light, and how long such windows have been in existence.

The ordinary person has no very definite knowledge of the law of easements, and it may thus happen that the architect's client imagines, on the strength of a 14- or 16-year enjoyment

of light, that he has obtained an easement, whereas he has obtained no rights whatever. If, however, the architect finds that undoubted rights of light have been acquired, and if, from such information as he is able to obtain, it seems to him probable that the proposed building operations will affect these rights, it is desirable for him to enter into communication with the architect to the servient owner. Then, as a matter of courtesy, the plans and sections of the proposed work will generally be shown to him, and he will have an opportunity of seeing to what extent, if any, the rights of light will be affected.

54. Interference With Rights of Light.—If there will be no appreciable infringement of the rights of light, the architect must report to this effect to his client ; but if, from the plans and sections, it appears that there will be such a serious interference with his client's rights as to constitute a nuisance, the architect must, of course, immediately take steps to safeguard his client's interests. In the first place, it will be well for him to approach the architect to the servient owner and point out that the works, if carried out as proposed, will probably result in legal action being taken by the dominant owner. It will frequently happen that a step of this nature will result in the proposed work being very materially altered, and the threatened interference with ancient lights entirely abandoned. Should, however, the work be proceeded with without any alteration, the architect will advise the dominant owner to take proceedings. A solicitor should then be instructed to deal with the case, if this has not already been done. All questions of procedure will then be settled by the solicitor, and the architect will be left free to prepare particulars to support his client's case in the event of its going into a court of law.

In preparing a draft of his evidence, the architect should especially bear in mind the fact that it is not the quantity of light of which the building is deprived that will be considered by the Court, but the state of the building after the light has been obstructed, and whether the reduction of light amounts to a nuisance, or whether the building is still well and sufficiently lighted for all ordinary purposes of occupancy.

55. Preparation of Drawings and Models.—Whenever a case of rights of light is brought before the Court, proper drawings showing, in plan and section and sometimes in elevation, the buildings in question must be prepared. It is permissible either

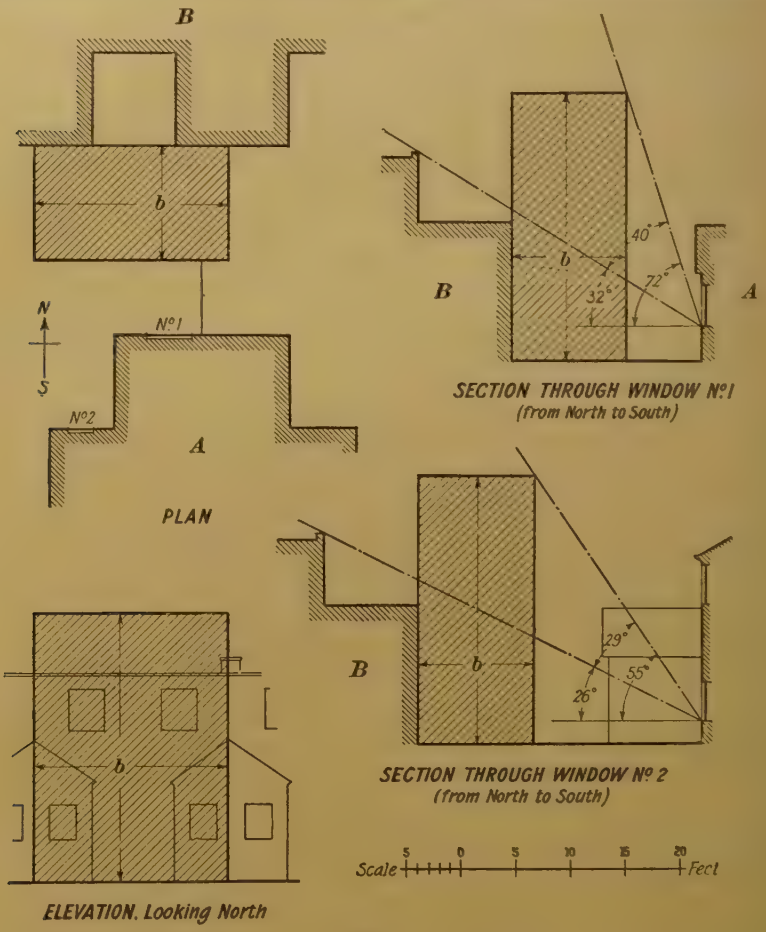

FIG. 4

for both the parties to the case to have drawings prepared, for the purpose of illustrating special circumstances which they respectively desire to emphasize, or, if there is agreement as to all the facts, a single set of drawings may be prepared and approved of by both parties. When the questions at issue

cannot be clearly shown by means of drawings, it is a very common practice to have models prepared.

56. Typical Set of Drawings.—In Fig. 4 is shown a suitable set of drawings for an ancient-light case. Here, in the building *A*, there are two windows, No. 1 and No. 2, that have rights of light. The owner of the adjoining tenement *B* is building on to his warehouse an addition *b* which extends up to the extreme limit of his site, and obstructs the light enjoyed by the windows in the building *A*. The new addition, which is here shown by light hatching, should in practice be shown in red hatched lines, and the angles of light of which the building *A* is deprived should be shown in blue lines and figures, all the old work being shown in black lines. It will be seen that the section planes are denoted in terms of the points of the compass, a practice which is always desirable in drawings prepared to illustrate questions of access of light.

As drawings in ancient-light cases are often looked at in great haste and by persons who have to bear in mind a great many questions of law and procedure, it is necessary to make such drawings as bold and clear as possible. All matter which is not material to the points at issue should be left out, and the points to which attention is particularly desired to be drawn should be boldly shown.

57. Position of Obstructions to Light.—The position of an obstruction to light is immaterial. The only point to be considered is whether the diminution of light is of such a nature as to amount to a nuisance. Thus, in Figs. 2 and 3, illustrating the case of *Colls* v. *Home and Colonial Stores*, it will be seen that the building obstructing the light is on the opposite side of the street, while in the case illustrated in Fig. 4 the obstruction of light is caused by the servient owner extending his building so as to cover

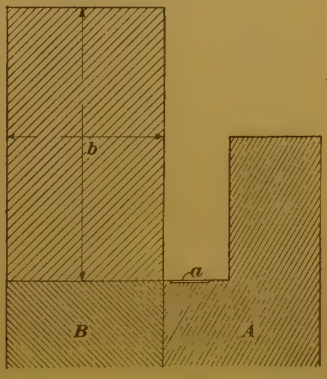

FIG. 5

over a portion of his back yard. Cases also sometimes occur in which light that is received sidewise is obstructed. An instance of this is shown in Fig. 5, where the window *a* of the building *A* has received light sidewise over the land at the rear of the building *B*, which light is obstructed by the erection of an addition *b* on this land. If the obstruction of light amounts to a nuisance, there is the same opportunity to take successful legal proceedings as in the cases previously mentioned.

EASEMENTS OF AIR

58. It is essential to the acquisition of an easement of air that the air, in entering into that portion of the dominant tenement which derives the benefit, should pass through some defined channel or aperture. It has been held that a claim for an easement of air by prescription cannot be substantiated if the servient owner has had no means of preventing the enjoyment of the air, which means he possesses only when the air passes through some defined channel. The blocking up of a window opening or other similar aperture for the passage of air is not, however, the only act which can be objected to as causing an obstruction of an easement of air.

It has been held that the construction of a skylight over a yard from which a window receives air, if the skylight materially impedes the passage of air, is an offence with regard to which successful action at law can be taken. It has also been held that the erection of very high walls round a court in such a manner as to impede the ventilation of a house having windows opening into the court is an offence in respect of which an injunction may be claimed with every prospect of success. Although a right of air cannot be claimed under the Prescription Act, there appears to be an equal right of obtaining an easement of air by prescription at common law as of obtaining an easement of any other nature in this manner. While there is a very considerable knowledge, among the general public, of the rights conferred by an easement of light, there is not so much appreciation of the importance of easements of air.

EASEMENTS OF SUPPORT

59. Case of Dalton *v.* Angus.—Just as the law as to rights of light is governed to a very great extent by the decision in the case of *Colls* v. *Home and Colonial Stores*, so also the law as to rights of support is very much bound up with the case of *Dalton* v. *Angus*. The circumstances on which the latter case was based were as follows: Dalton, as the contractor engaged in erecting a new Government office, had carried out excavations by which the collapse of a building on the adjoining property was occasioned. This building, and the adjoining building on the land on which the Government office was built, were more than 100 years old, and up to about 27 years before the occurrence of the accident had both been occupied as dwelling houses. Then, however, the owner of the building afterwards possessed by Angus converted his house into a factory, thereby materially increasing the vertical pressure on his own soil and consequently the horizontal pressure on the adjoining soil. No objection to this action was raised by the adjoining owner. Dalton, in excavating for the cellars of the new Government office, caused the factory on the adjoining land to collapse.

60. Course of Legal Proceedings.—When the case of *Dalton* v. *Angus* was heard in the High Court, a decision was given, by a majority of the Court, in favour of Dalton, on the principle that the presumption of a grant was of no avail if it could be proved that no grant had actually been made. It was further considered that the enjoyment of a right of support was not capable of being interrupted by reasonable means, and that, on this account also, no easement could be acquired. The decision was, however, reversed by a majority of the Court of Appeal, there being also in this Court a difference of opinion among the judges. The case was then taken to the House of Lords.

The law lords approved of the action of the Court of Appeal, although they differed somewhat as regards the grounds on which the decision should be based. The chief points on which opinions differed were whether an easement of support was a negative or a positive easement, and whether it could be acquired under the

Prescription Act. As regards the question of no grant having been made, there appears to have been a unanimous opinion that a 20-year enjoyment of support confers a right under the doctrine of presumed grant.

61. Support by Buildings.—The law as to the support of a building by another building appears to be very similar to that affecting the support, by the adjoining soil, of land on which a building or buildings have been erected, a 20-year open enjoyment being sufficient to confer an easement of support. It is, however, essential to the acquisition of the easement that the enjoyment shall have been open, so that it is known to, or could reasonably be ascertained by, the owner of the servient tenement. On this account difficulties may occasionally arise, not, of course, when a portion of one building is directly carried by a portion of another building, for such enjoyment is almost invariably obvious, but when walls of two buildings are built side by side and one of them derives its support from the other. Such a case will be governed by whether or not the enjoyment has been of such a nature as to be open, a question which will be determined principally by the presence or otherwise of external signs in the construction of such a character as to indicate the enjoyment of support.

EASEMENTS OF WAY

62. Use of Rights of Way.—It appears from many decided cases that where a right of way is granted by deed, or acquired by implied grant or by prescription, the way may be used only for such purposes as are specified in the grant or were involved in the acquisition of the prescriptive right. It has, for instance, been held that a right of way for wheeled carriages will not confer a right to drive cattle, that a right of way for farm purposes will not give a right to cart coal, and that a way the use of which is allowed for ordinary business purposes may not be used as an approach to a railway station.

This matter of restricted use is a very important one, and one very likely to affect the work of an architect, as, generally speaking, it is only when alterations in use and arrangement are

proposed that his services are in request. An architect, when dealing with a site of which any part is approached by an easement of way, should in the early stages of his work inquire whether or not the use of this right of way is restricted, and, if so, to what extent. Easements of way admitting of unrestricted use are sometimes met with, but in the majority of cases where the easement has been obtained by grant, and in practically all cases where it has been obtained by prescription, it will be found that the use of the way is permissible only for some particular purpose.

63. Effect of Alteration of Dominant Tenement.—The burden imposed by a right of way over a tenement is liable to be indirectly increased by an alteration of the dominant tenement. In such a case there is a probability that a court of law will hold that the easement has been extinguished as a result of the burden having been increased. A simple instance of the imposing of an increased burden by the alteration of the dominant tenement is that of the building of two houses in the place of one to which a right of way was enjoyed. It will be evident that in such a case the alteration of the dominant tenement is only the indirect cause of the imposing of an increased burden, the direct cause being the increased use of the right of way which results from the alteration.

EASEMENTS OF WATER AND DRAINAGE

64. Natural Rights to Water.—The owner of property on the side of a natural stream is usually, when speaking of rights as to water, termed a *riparian owner*. Each riparian owner has equal natural rights as regards a stream. Each of such owners has a right to have the stream run in its accustomed course, a right to a reasonable use of the water, and a right to receive the water in an unpolluted state. The natural right to the flow of water only applies to water flowing in a defined channel. As regards artificial watercourses, there are, of course, no natural rights whatever.

65. Character of Easements of Water.—Easements in water may be acquired both by riparian and other owners. An easement may take the form of a right to an excessive use of the

water of a stream, or a right to pollute the water as a result of manufacturing operations, or a right to dam up the stream and thereby throw back some of the water on the lands of riparian owners bordering on the upper portion of the stream. It is also possible to obtain an easement to discharge water on to the land of another owner. Easements in water may be acquired both by grant, direct or implied, and by prescription. As in the case of rights of way, proof of enjoyment as of right for 40 years is necessary to make a claim for an easement of water under the Prescription Act absolute and indefeasible, but in many cases it will be possible to establish a claim based only on a 20-year enjoyment. Easements cannot, generally speaking, be acquired in respect of water which does not flow in a defined channel either above or below the ground. But the subject is one of very considerable complexity, and a proper understanding can only be obtained by a careful reading of the reports of the various cases which have been decided in the law courts.

66. Easements of Drainage and Sewerage.—It is possible to acquire an easement to discharge rain-water into the gutter of an adjoining house, and in a similar way an easement may be acquired for drainage or sewerage. Such an easement may, of course, be obtained by direct grant. As regards its acquisition by implied grant, there is a little uncertainty whether, on the severance of two tenements, the right of drainage passes with the tenement sold. If the tenement first sold is drained by means of a pipe that passes through the tenement retained, it seems evident that an easement of drainage is impliedly granted. If, however, the tenement over which the drainage is run is sold first, there is some uncertainty whether the quasi-easement of drainage is extinguished with the sale, or whether it can be considered so necessary to the enjoyment of the tenement retained as to become an easement of necessity. The determination will apparently be governed by the special circumstances of the case. An easement of drainage or sewerage can also be acquired by prescription so long as the easement is of such a nature that its existence can be ascertained by careful inspection, but cases of this kind are comparatively rare.

GENERAL PRACTICE AS REGARDS EASEMENTS

67. Just as in the case of ancient lights, so as regards other easements, the architect's duties will depend on whether he is acting on behalf of the owner of a dominant or of a servient tenement. When he acts for the owner of a dominant tenement, it is his duty to see that the rights of his client are in no respect prejudiced by any action of the owner of the servient tenement. When he acts for the servient owner, he must see that the burden of the easement to which the latter's tenement is subjected is not in any way increased. But his principal duty when acting for the owner of a tenement which is subject to an easement will be that of endeavouring to arrange any work of which he is in charge so that both the design of the work and the rights of the dominant owner are not prejudicially affected. It will often be found impossible to avoid doing one of these undesirable things. In such a case it is necessary for the architect to obtain instructions from his client as to whether he is to try to negotiate some arrangement with the dominant owner, or whether he is to carry out the required work as well as circumstances permit, having due regard to the rights of the dominant owner.

LAW AS TO EASEMENTS IN SCOTLAND

COMPARISON WITH ENGLISH LAW

68. Use of Term Servitude.—The law as to easements in Ireland is similar to that applying in England and Wales, but in Scotland, although there are many points of similarity, it differs in several very important respects from the English law. An easement in Scotland is generally termed a **servitude.** This term is also used in English law, but it is there generally applied to the class of rights comprising both easements and profits à prendre. Servitudes are considered in Scotch law to be divided into two groups of **positive** and **negative servitudes,** in a similar manner to easements in English law, and a servitude can only

be acquired in respect of a tenement. There is thus a very considerable similarity between the bases of the law in the two countries.

69. Acquisition of Servitudes in Scotland.—The chief difference between the law in England and in Scotland lies in the manner in which easements may be acquired. The majority of servitudes in Scotland are not able to be acquired by prescription, and in no case can a servitude be acquired under the Prescription Act, for this Act does not extend to Scotland.

The most important instance of the difference between English and Scotch law is found in the acquisition of rights to light. The only method by which a servitude of light may be acquired in Scotland is by direct grant. This is in striking contrast to the state of affairs in the rest of the United Kingdom, where easements of light are in the great majority of cases acquired by prescription. From the practical standpoint, the fact that a right of light is in Scotland not obtainable by prescription is of great importance. It follows that, in ordinary cases, there will be no restrictions, other than those of the local by-laws, to limit the utilization of a building site. It also follows that an architect carrying out building work in that country, unless special rights of light by direct grant have been obtained, will be compelled to set his building back from the rear and side boundaries of his site, in order to obtain the necessary light.

It is likewise impossible to obtain a servitude of air by prescription. As regards easements of way, water, and support, it appears possible to obtain rights of this nature by prescription. But the right to receive support for one building from another is apparently treated as being on a basis different from the right to receive support for a building from the adjoining soil, and it seems questionable whether, in this first-mentioned case, it is possible to substantiate a claim for a servitude by prescription.

70. Servitudes by Implied Grant in Scotland.—The law with regard to the acquisition of servitudes by implied grant is not on such a definite basis in Scotland as in the rest of the United Kingdom. For one thing there has not been such a large number of cases decided under the Scotch as under the English law.

Generally speaking, it appears that negative servitudes are not conferred by implied grant, except in a case where the servitude is essential to the enjoyment of the tenement; but from their nature, negative servitudes rarely come within this category. An understanding of the Scotch law on this subject cannot be arrived at except by means of a careful study and comparison of the decided cases, and many of these will be found to be so influenced by special circumstances as to be of no great value as general guides.

71. Right of Eavesdrop.—A special servitude, termed a **right of eavesdrop,** is met with to some considerable extent in Scotland. A right of this nature is also recognized as an easement in English law, but it is of comparatively rare occurrence. The right consists in being permitted to drop the water from the roof of a building on to the adjoining land. The right may be acquired either by grant, direct or implied, or by prescription. Where a building has a right of eavesdrop, it is customary to leave a space of about 9 inches in width when building on the land which is subject to the servitude.

RIGHTS AS TO PARTY WALLS

PARTY WALLS IN ENGLAND, IRELAND, AND WALES

72. Ownership of Party Walls.—Except in the County of London, where the provisions of the London Building Act, 1894, as to party walls apply, the rights of owners with regard to party walls are regulated by common law. The law as to party walls in London is not dealt with here. Where there is definite knowledge of the exact position of the boundary between two premises, and it can thus be shown to what extent the party wall rests on the land of the respective owners, each owner is considered to be possessed of that portion of the party wall which rests on his land. It rarely happens, however, that the boundary can be

so clearly defined, and in such a case the wall and the land on which it stands are held in common by the two owners who use the wall, the owners being considered to be tenants in common. Most rights in regard to party walls are of this kind, and though they are not easements, they are of a somewhat similar character. Where walls separate unbuilt-on portions of sites belonging to different owners, they are generally termed *party-fence walls*.

73. Rights of Owners as Regards Party Walls.—The rights and liabilities of owners of buildings in respect of party walls are of a somewhat uncertain character, and depend to a very considerable extent on the circumstances of each case. It is most desirable in practice, when points of difficulty arise, to obtain the advice of a solicitor before proceeding to take action. Treating the subject generally, there are, however, a few rules which may be held in mind. When a new wall is built as a party wall, the owner who builds it will have a right by custom to require the owner on the other side of it to pay half the expense of erection as soon as he commences to use the wall. It was held, in 1873, in the case of *Weston* v. *Arnold*, that where a party wall was carried up so as to form an external enclosure to the higher of two buildings, such upper portion of the wall was an external wall. The practical importance of this decision is that the by-laws may prohibit the making of openings in party walls, while, of course, there is no restriction on the making of openings in external walls.

74. Expenses of Rebuilding Party Walls.—Generally speaking, it may be said that an owner of a building enclosed on one side by a party wall has a right at his own expense to take down and rebuild the wall, or to underpin it, so long as he does no damage to the adjoining property. Should a party wall in a very bad state of repair be rebuilt by the owner of the property on one side of the wall, such owner may have difficulty in making the owner on the other side of the wall pay his share of the cost. In a case of this kind it is necessary for application to be made to a Court of the Chancery Division, and for the facts to be placed before the Court, who will then have a right to apportion the expenses, if such is deemed necessary or desirable. In

consequence of the difficulty likely to arise in respect of expenses, it is most desirable for the owner who proposes to rebuild the wall to come to some arrangement with the other owner having an interest in the wall, before any work is commenced. This method of making an arrangement with the adjoining owner is to be recommended in all cases where it is in any way possible.

PARTY WALLS IN SCOTLAND

75. Mutual Gables.—In Scotland, party walls are termed **mutual gables,** the term **mutual wall** being applied to walls separating unbuilt-on portions of sites belonging to different owners. This latter term is thus equivalent to the term party-fence wall in use throughout the rest of the United Kingdom. From the legal standpoint, the ownership of mutual walls and gables appears to be uncertain. Such a wall or gable may be considered either as common property or as belonging for half of its thickness to the owner on each side, who, in addition to being possessed of one-half of the wall, will also have a right of common interest in the other half. From the practical standpoint, however, the question is immaterial, as the rights of the owners on either side are defined in a much more thorough manner than those of the owners of party walls in the rest of the United Kingdom outside the Metropolis.

76. Rights in Respect of Mutual Gables.—Where, as is customary in closely populated districts, land is sold in building plots of such a size that the houses must be built in a more or less continuous row, the right of any purchaser to build a mutual gable is implied. This work must be carried out at his own expense, but he has the right to demand the payment of half the cost of building the mutual gable before he allows the owner on the other side of the wall to make use of it, even although such owner requires to use it only for a small portion of its height. Where a mutual gable is used by the owners on either side, all necessary repairs must be carried out at the mutual expense of the two owners, and either owner is able to enforce the carrying out of such repairs. Important alterations to mutual gables

may, generally speaking, only be made by mutual consent. Each owner, however, may carry out works on his own side of the mutual gable, so long as he does not alter the character of the mutual gable or affect the rights of the owner on the other side of the wall. An owner has the right at any time to raise the height of a mutual gable, and if later on the adjoining owner also makes use of this raised portion, he must pay half the cost of the work.

BUILDING CONTRACTS

NATURE OF A CONTRACT

FORMS OF A CONTRACT

SIMPLE CONTRACT

1. Definitions.—A **simple contract** is an engagement entered into between two or more persons whereby, in consideration of something done or to be done by one contracting party or parties, the other contracting party or parties promise to do or omit to do some act. It may be implied, verbal, or written, but to be binding it must have: a definite object, which of course must be legal; a good and valid consideration; and the consent of all parties concerned, who must be qualified to contract. Should one of the parties be able to show that he misunderstood the terms of the contract, he can apply to the Court to have it revised or annulled.

It is of the utmost importance that this rule be kept in mind in dealing with builders, especially when dealing with men having a small business, who are often deficient in the education that would enable them to grasp the entire meaning of the agreement into which they are entering. With such men the whole of the agreement should be read aloud and all doubtful points explained before the contract is signed. If this is impossible, a copy of the proposed agreement should be sent with a request that the party will read it through carefully before he signs it. Further, it is important, when the contract is being constituted by means of letters passing between the

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parties, that the acceptance shall be definite, unconditional, and shall have direct and exclusive reference to the offer made. An acceptance which is conditional is not a legal acceptance. The negotiations should be so conducted that all outstanding points are settled, then, if an offer is made in direct terms and accepted in similar terms, it will constitute a valid contract.

2. Consideration.—Since a sufficient consideration or recompense is the very essence of a contract not under seal, unless such consideration exists and is legal the contract will be void. A valuable consideration may be one of four kinds: (1) When one party gives money or goods on contract that he shall receive money or goods for them in return. This class includes all loans of money upon bond or promise of repayment, and all sales of goods in which there is either an express contract to pay a fixed sum for them, or an implied contract to pay as much as they are worth. (2) When two parties agree to do any positive act mutually, or when one party agrees to forbear on one side in consideration of something done on the other side, or when mutual forbearance on both sides is agreed upon. (3) When one party agrees to perform anything for a price either specifically mentioned or left to future determination, or when a servant hires himself for certain wages, or contracts to do service in order to earn a specific sum. Or (4) the direct counterpart of this. When one party agrees with a servant to give him specific wages on his performing certain work.

3. Sufficiency of Consideration.—It is not essential that the consideration for a contract shall be adequate in point of actual value. The law does not interfere with the free exercise of the judgment and will of the parties to the contract, as it allows them to be sole judges of the benefits to be derived from their bargain. It is, however, necessary that the consideration shall be of some value, but it is sufficient if it is of slight value only, or even if it is such as could be of value.

4. Amount of Obligation.—The amount of trouble or obligation which the party to whom the promise is made takes upon himself is immaterial, provided it is not utterly worthless.

5. Contracts in Writing.—The Statute of Frauds requires certain contracts to be in writing, but contracts between architect and client or between owner and builder do not come within this category, and need not be in writing unless the works in question are to be performed at some date more than 12 months distant. But in practice it is desirable that all contracts should be in writing, for verbal arrangements are always likely to be indefinite, and to become matters of subsequent dispute.

6. Implied Contracts.—It is not necessary that a contract should be in the form of a definite verbal agreement, for **implied contracts** are met with in an architect's practice, not that they occur in respect to those which may be made by his clients by his advice, but in cases where he is consulted with regard to a builder's account in respect of work not carried out under an architect's superintendence, and where there has been no written contract. Since an implied contract is a recognized form of simple contract, all the previously stated rules apply, and the parties are bound just as much as if there were a definite written agreement. As an illustration, it may be stated that the fact of a builder having executed work with the knowledge of a building owner constitutes a contract by which the building owner is obliged to pay for the work done. The amount of payment must be such as can be proved to be fair and adequate, taking into consideration all the circumstances of the case.

7. Stamping.—Contracts when in writing and applying to matters of the value of £5 and upwards require **stamping**. This may be done by affixing a sixpenny stamp, which is cancelled by writing on it. Instead, when signed, the contract may be taken to Somerset House, or forwarded there through the local post office, for the purpose of being stamped. Should the contract neither be stamped when signed, nor stamped at Somerset House within 14 days from the date on which it was signed, it is not admissible as evidence in a court of law until it has been stamped. This can only be done by sending it to Somerset House, where the authorities will stamp it, after exacting a fine, the maximum amount of which is £10. It is, of course, desirable for the signatures of the parties to a contract to be properly witnessed.

CONTRACTS UNDER SEAL

8. **Transactions With Corporate Bodies.** — An architect instructed to do work for any corporate body, including a joint-stock company, should make it a point to obtain a proper **contract under seal.** This is necessary, because in matters of importance the officials or directors of corporate bodies have no power to bind the local authority or company which they represent. The architect should also make sure that the contract is within the scope of the body which enters into the contract. If it is a local authority, it is necessary to see that the particular work is within the statutory powers of the body in question; or, if the contracting party is a company, the contract must be within the purposes of the memorandum of association of such company. Of this character, also, are the leases of land and buildings and bonds which are occasionally given by a contractor to his employer, when the ordinary building contract is in respect of large works. In the case of a building contract where the architect is, of course, not one of the parties to the contract, his responsibility will merely consist in advising the solicitor preparing the contract as regards technical points within his special experience.

CONTRACT BETWEEN ARCHITECT AND CLIENT

THE ARCHITECT'S POSITION

9. When the subject of contracts in relation to the erection of buildings is mentioned, persons naturally consider that reference is being made to the ordinary building contract, but it must not be forgotten there is also a contract between the architect and his client. The exact terms of this are of great importance if there is any dispute as to architect's fees. Simple contracts between architect and client may be either verbal or in writing, but the latter is the more desirable. A specially drafted formal contract is, however, rarely used, except in dealings with business

firms. The details of the arrangement are usually settled by letter, since the letter in which a definite offer of work at stated fees is made constitutes a valid contract, if it is properly accepted without reservation, and stamped at Somerset House. An architect's business relations with a client with whom he is on familiar terms are not infrequently, at least in the early stages, of an entirely verbal character, although it is in the interests of both parties to commit the details of this arrangement to writing.

10. Relations With a Corporate Body.—An architect having business relations with a corporate body should insist on having a proper contract under seal. If he does not, and then afterwards finds that payment is withheld, and he has no remedy, he will have only himself to blame. The necessity of obtaining contracts under seal in such cases has been strikingly exemplified in important cases, where architects, for the lack of taking this precaution, have not been able to recover their fees.

11. Architect's Fees.—An architect is an agent whose right to commission or reward for his services is regulated by the custom or usage of the profession. The Royal Institute of British Architects issues a schedule of minimum fees which, being accepted by the profession, may be put forward as the custom of the profession. This schedule is given at the end of this Section. It is possible to contract for fees in excess or below the schedule, though the latter course will hardly be adopted, as the fees are to be considered as a minimum. Where the schedule does not absolutely apply, the law will treat a question of payment for work done on the principle of, how much is it worth ? This, of course, is a question of evidence in every particular case.

12. The Institute Schedule.—The schedule of charges just mentioned provides that the usual remuneration for an architect's services is a commission of 5 per cent. on the total cost of works executed under his direction. Where the works cost less than £1,000, or where designs for furniture, fittings, or special decorations are required, 5 per cent. is stated to be unremunerative, and the architect's charge is to be regulated by special circumstances and conditions. Where the architect has drawn out

the approved design, with plans, elevations, sections, and specifications, the charge is $2\frac{1}{2}$ per cent. on the estimated cost. Where also tenders have been procured in accordance with the instruction of his employer, the charge is $\frac{1}{2}$ per cent. in addition, making a total of 3 per cent. The architect is entitled during the progress of the work to payment by instalments on account at the rate of 5 per cent. on the amount of the certificates when granted; or, as an alternative, to half the amount of the commission on the signing of the builder's contract, and the remainder by instalments during the progress of the work.

13. Disputes Between Architect and Client.—The basis of any dispute between architect and client is almost invariably the question of fees, for there are few other points in which they can come into conflict. A dispute having arisen, the character of the contract between the parties is of great importance. If there is a written contract in reasonable terms, the occurrence of a dispute will be most unlikely, and, should it arise, it will often be settled by either of the parties getting legal advice on the interpretation of the contract. If there is a written contract, and the architect has been so unwise as to consent to his remuneration being contingent upon a certain event, he will be unable to recover any expenses until such an event happens, which possibly may be never. Thus, if an architect contracted to be paid on the approval of the plans by the owner, and the latter did not approve the plans, the architect could recover nothing.

14. Where there is no written or verbal agreement as to fees, and a dispute as to fees arises after the practical completion of the building, it is probable, if there is no evidence that a lower rate of payment was intended, and the architect's work has been efficiently carried out and the building erected within the contract price, that a court of law, upon evidence of the custom of the profession being given, will allow the architect his 5 per cent. on the cost of the building. But cases which go before the courts are usually more complicated, the most common cases being where the ascertained cost of the building is found to be very much in excess of the architect's original estimate, and the owner decides not to build, and refuses to pay the full

amount of the architect's claim for fees. Every case of this nature will of course be dealt with on its merits ; but, speaking generally, it may be anticipated that, if tenders have been obtained and the cost is not very largely in excess of the architect's estimate, the architect will be allowed a percentage approximating 3 per cent. on the amount of the tender. If, however, no tenders have been obtained, the architect's claim for fees is likely to be judged on the amount of time he has expended in the preparation of the drawings.

15. Ownership of Drawings.—Although, in the opinion of practically the whole architectural profession, the drawings and specification ought to be considered merely part of the implements of an architect's craft with which he produces the required building, there seems no doubt that the owner can legally require from the architect a copy of the drawings and specification at the conclusion of his engagement. Cases decided in the courts have placed this question almost beyond dispute.

16. Death of Either Party.—The architect's contract with his client being one of personal service, it is dissolved by the death of either party. This is in marked contradistinction to an ordinary contract between owner and builder, which, in the event of the death of either party, passes to his executor.

CONTRACT BETWEEN OWNER AND BUILDER

GENERAL CONSIDERATIONS

17. Special Features of a Building Contract.—A building contract differs from one of ordinary type in that the building owner, one of the contracting parties, generally has not the technical knowledge necessary to enable him to describe what he wants done, and therefore he must employ an architect to prepare the drawings and specification which form the customary basis of a contract. Also, the fact that the details of the required work must be put in such a form that they can be conveniently priced

by builders in competition with one another, renders necessary the employment of an independent quantity surveyor, unless the architect undertakes this duty himself, which, however, is somewhat unusual in large contracts. Further, it is practically an invariable custom for the contract to give the architect the responsibility of adjudicating upon questions arising in the course of the work, subject in some specified instances to an appeal to a previously appointed arbitrator.

18. Positions of Architect and Quantity Surveyor.—The architect must act in a dual capacity. In dealing with the majority of questions he must act as the agent of the owner and see that his client gets proper value in the way of workmanship and materials in the work he is paying for. But in some instances he must occupy the position of arbitrator, and hold the balance fairly and evenly between the interests of the owner and the contractor.

19. The quantity surveyor is generally chosen by the architect, acting as agent of the owner. It is highly desirable that explicit directions from the owner as to the engagement of a quantity surveyor be obtained, although it is possible that this might not be considered essential where an architect has been instructed to obtain tenders, for in such a case it might be considered that there was an implied instruction for him to employ a quantity surveyor, as, except in the case of small buildings, builders will not tender unless quantities are supplied. Though the quantity surveyor in effect always receives his remuneration from the building owner, there is a difference in the method of payment, according to whether a tender has been accepted. If no tender is accepted, the quantity surveyor may claim his fees from the building owner ; but when a tender is accepted, the successful contractor usually becomes responsible under the terms of the contract for the quantity-surveyor's fees. As a builder knows this, he allows an item for quantity-surveyor's fees in the amount of his tender. Where the architect also occupies the position of quantity surveyor, the receipt by him of any moneys from the builder is open to misconstruction ; and it is a desirable, though hardly usual, practice for the fees for quantities in such a case to be paid by the owner to the architect,

without their passing through the hands of the builder. Many public authorities make it a practice to appoint their own quantity surveyor and pay him direct.

20. Drawings and Documents in a Building Contract.—The items constituting a building contract are the drawings which show the size, character, and method of construction of the building to be erected, the specification which describes the nature and quality of the materials to be used, and a list of conditions, termed the *conditions of contract*, which regulate the detailed relations between the owner, the architect, and the contractor. Sometimes the quantities are also included in the contract, but there are considerable differences of opinion as to the desirability of this course.

21. The Position of Quantities as Regards the Contract.—It is a growing practice to make the quantities a part of the contract. From the builder's point of view this is a more equitable arrangement than to base the contract only on the drawings, specification, and conditions, for tenders are invariably based on the quantities, and yet, if the quantities are inaccurate and do not form part of the contract, the builder may be compelled, if the inaccuracy takes the form of an omission, to supply material and workmanship not allowed for in his tender, and for which, owing to no fault of his own, or of any person in his employ, he will not be able to claim payment. But, despite this fact, builders are usually quite willing to tender in cases where the quantities do not form part of the contract, provided that they have been prepared by a competent surveyor. The advantage of not having the quantities part of the contract is that the owner then has the satisfaction of knowing definitely the amount which he will be called upon to expend, whereas, if the quantities are made part of the contract, he may be called upon, through inaccuracies in the quantities, to pay a larger sum than he had anticipated. In cases where quantities do not form part of the contract, the course is sometimes adopted, in fairness to the successful contractor, of allowing him a little time to compare the quantities with the drawings and specification and satisfy himself as to their substantial accuracy.

22. No Implied Warranty.—Where a builder agrees to execute certain work according to a plan and specification, there is not any implied warranty on the part of the employer that it can be done under the conditions of the specification or in the way shown by the plan. It is for the contractor to satisfy himself on this point before tendering. If the work cannot be done in that way, and the contractor does it in another way which is more expensive, he cannot recover the extra expense in an action for damages, as for a breach of the supposed warranty.

23. Schedule of Prices.—As an alternative to a bill of quantities, sometimes a schedule of materials and labour forms part of the contract. This is priced by builders in competition with one another in the same manner as a bill of quantities, and the work is measured up on completion and the contractor paid on the work executed in accordance with the prices which he has attached to the schedule. This method is not infrequently adopted by architects engaged in work of the very best class, where the details are often varied to suit the fancy of the client as the work proceeds and where expense is a secondary consideration. Work executed under schedule almost invariably costs more than when quantities are taken off. The policy of inviting tenders to a schedule is, however, frequently adopted by municipalities in the case of work which, from its character, cannot very well be represented by a bill of quantities.

SPECIAL POINTS OF DETAIL

SUBCONTRACTING

24. Architect's Consent Necessary.—It is almost an invariable practice for the conditions of contract to contain a clause that the contractor shall not sublet any portion of the work without the consent of the architect. As in practice subcontracting is most customary, this clause generally takes effect in ensuring that every subcontractor is approved by the architect, for, although the latter would be acting entirely contrary to current

practice if he refused to allow subcontracting, it is most clearly his duty to see that any subcontractors employed may be reasonably relied on to produce sound work. If any firm is proposed whose work has in previous instances been found to be untrustworthy, it will be well for the architect to exercise his right of veto.

25. Responsibility of General Contractor.—Not only when there are subcontractors who have been directly engaged by the general contractor, but also when there are tradesmen chosen by the architect to execute special work, it is most desirable that all payments should be made by the general contractor, and that he should be required to undertake the entire responsibility for the sufficiency and quality of the whole of the work and for any delay which may occur. This is best effected by a clause stating that the special tradesmen are to be deemed subcontractors employed by the contractor. If this action is not taken, friction will almost certainly occur between the specialist firms and the general contractor, and if delay occurs it will be most difficult to determine the responsibility.

VARIATIONS FROM CONTRACT

26. In practice, it unfortunately often happens that in the carrying out of works under a contract, some variations from the drawings and specification are required. As the work proceeds the owner may change his mind as to the solution of some minor point in planning, or he may require fittings to be provided additional to or of a more expensive character than those in the original contract. Then the architect is not infrequently required to arrange that other portions of the work are either omitted or carried out in a less expensive manner, so that at the settling up which takes place on the completion of the contract, the omissions will, as nearly as possible, balance the extras ordered by the owner, and the sum payable to the builder be approximately the same as that of the original contract. There is almost always a clause in the conditions of contract to the effect that no claim for extra work or materials

will be allowed unless a written authorization with regard thereto by the architect can be produced. In the preparation of the drawings and specification the greatest care should be taken by the architect that all details are properly provided for, so that no extras may be rendered necessary, other than those which may be due to compliance with some special request of the building owner made subsequent to the signing of the contract. There is usually a clause in the contract to the effect that variations are to be measured and valued either by the architect or by the quantity surveyor.

27. Additions and Alterations.—Though additions have been ordered and made on a house that is being erected, and which a builder has contracted to finish for a fixed sum, the contract is not vitiated. The contract must still be taken to exist as far as it can be followed, and the additions must be paid for at the usual rate of charging; that is, on the basis of the prices in the original estimate. But if the plan by which the builder contracted to work is so altered that it is impossible to trace the contract and to say to which part of the work it shall be applied, the builder is permitted to charge for the whole of the work by measure and value as though no such contract had been made.

PAYMENT OF CONTRACTOR

28. Method of Payment.—Contractors for building work are usually paid by instalments during the progress of the work. The architect is generally required to issue certificates when the value of the work executed has reached certain figures given in the conditions of contract. Payment is then due on a certain proportion of the value, usually 80 per cent., of such work, until the balance amounts to a stated sum, after which the payments are made for the full value of the work certified. When the works are practically completed, the contractor receives a portion of this balance, but the remainder is retained until the lapse of a stated time from the date of the completion of the building. This rather complicated arrangement for payment is due to a desire to safeguard the interests

of both the owner and the contractor. The owner by means of the retained balance ensures that the sum paid to the builder is well within the value of the work executed, while the builder, by receiving instalments during the progress of the work, is enabled to carry out the contract with a very much smaller capital than would be required if payment were reserved until the completion of the work. Thus the owner indirectly benefits, for if the builder had to employ further capital his price for the work would be proportionately higher.

29. Proportional Payment.—Where the contract is for work complete and entire, the builder who fails to make the work complete cannot claim for the proportional amount of work and material expended. But if it is not stated that the work must be completed before any remuneration shall be due, the builder may at any time refuse to continue the work, unless he is paid for what he has performed, and he may recover the value of what he has actually done.

30. Payment Upon Architect's Certificate.—If a contract for the erection of a house or building contains a clause that the employer will pay, upon receiving the architect's certificate that the work has been done to his satisfaction, the obtaining of the proper certificate is a necessary preliminary to the right to receive payment. In other words, the builder has accepted the position that before he can sue the employer for money he must first obtain the architect's certificate that such money is due to him for the work executed.

31. Inferior Work and Materials.—In the case of work carried out under a provision that a specific sum of money is to be paid for the performance of the work, if it is shown that the work or materials were of an inferior description and value to what was intended by the contract, the amount agreed for payment may be reduced, and the demand may be altogether defeated, if it can be shown that the work is totally inadequate to answer the purpose for which it was undertaken.

32. Overpayment.—If overpayment is made for work, under a mistake of the real facts, and the payer has not omitted to avail

himself of the means of knowledge within his power, the money paid may be recovered. Where money is allowed on account, under a mistake as to a material fact, it also may be recovered. But where, on a settlement of accounts between building owner and builder, either party agrees to a balance due to the other party, this will confer a right to the payment of such agreed balance.

RESPONSIBILITY OF ARCHITECT

33. Architect's Position.—The architect must consider, not only the question of the contract between the building owner and the builder, but the position which he holds to both parties in the matter. Although he is the agent of the building owner, he is at the same time in a judicial position with regard to many questions arising between owner and builder, and he must not, through being associated in many cases with the interests of his employer, forget that in many instances it is his duty to consider the interests of both parties to the contract. As the building owner is liable for the acts and contracts of his agent the architect, within the scope of his employment, although no express command need be proved, his assent must in all cases appear, either by express evidence thereof or by proof of facts from which the law will raise an inference that such assent was given. The owner is not bound if the agent's act or contract does not fall within the general purview or scope of his powers. In this connection, what is customary as between employer and architect will generally determine the liability of the building owner; but such custom must be reasonable, or it will not be recognized as binding on an employer who was ignorant of it or who had not consented to act upon it. Where an agent has exceeded his authority, the employer will be liable if he subsequently recognizes or assents to the agent's act or contract, because, as an authority may be presumed from previous employment in similar acts, so the same presumption arises from subsequent assent and acquiescence. Slight evidence of ratification is sufficient to bind the employer, and if the agency be recognized at all, it will be held to have been recognized throughout.

34. Architect's Liability as Agent.—The architect must take great care that he does not in his capacity as agent for the employer make himself personally liable under the contract. Wherever an agent enters personally into a contract, or pledges his own credit by omitting to disclose the name of his principal or otherwise, this gives the other party a right of action against him; and where an agent enters in his own name into an agreement in writing, he cannot relieve himself of his liability thereon, even if he can show that, at the time the agreement was made, the other party was cognizant of the fact that he was an agent only. It would appear, therefore, that a person in entering into a contract, although such contract is expressed to be made by him on behalf of another, may still contract thereby in such terms as to bind himself personally. The point is, whether or not the contract, looked at as a whole, appears to have been intended to bear the construction that he should be personally liable thereon. From this it follows that an architect personally undertaking the terms of a settlement of a dispute is liable to be sued for performance thereof, but it is open to him expressly to stipulate that after a certain time any liability he may be under shall cease. An architect ordering materials or fittings for the execution of work under his charge should take care that any contract made is expressly entered into on behalf of the building owner, for, if he does not state the name of his employer, he may render himself personally liable.

35. Liability to Third Parties.—An architect, acting as agent, is liable to third parties, not only when in dealing with them he knowingly exceeds his authority, provided his want of authority is not known to the person with whom he deals, but even if he does an act which is not within the scope of his authority, although he may believe it to be so. This, however, does not hold good if the architect, in committing the act at the same time, gives to the person with whom he is dealing such information as would enable him to judge of the authority under which the architect professes to be acting.

36. Liability Through Misrepresentation.—When acting as an agent, an architect is of course liable where he fraudulently

misrepresents the extent of his authority. To make him liable, however, it is necessary that the misrepresentation shall be as to some matter of fact. A misrepresentation, founded merely on a mistaken view of the extent of his authority, in point of law will not make him liable to the person to whom such representation was made. Should an architect enter into a contract without authority, he does not thereby render himself liable to be sued under the contract. From this it would appear that where an architect who has no authority to do so executes a written contract in the name of his principal, making it plainly appear that his own name is only added as agent for his principal, he cannot be treated as a party to the contract or be sued upon it, unless it can be shown that he is the real principal.

37. Violation of Duty.—As an agent, an architect is liable to his principal for any loss incurred through violation of his duty, and may have to refund to the principal any commission he may dishonestly make. He must also pay over to his principal, on request, any money he may receive on his account. Should he refuse or neglect to pay over such money, he is liable to pay interest on the money from the date of such refusal.

38. Negligence.—An architect is presumed by the law to have expert knowledge of matters with which he deals in the ordinary course of his business ; therefore, any ignorance on his part which involves his employer in loss is **negligence.** An architect is liable for any loss that his employer may incur through his negligence or his carelessness. He is bound to use ordinary care throughout his business dealings. From this, however, it must not be supposed that an employer can demand exceptional skill. All that he is entitled to claim is that the architect shall bring a reasonable degree of skill to bear upon any problems he may be called upon to determine, and that his skill shall not be less than the average architect would show in similar circumstances. Thus, even if a serious mistake is made, no action for negligence can be maintained if the architect is able to prove that he exercised a reasonable amount of carefulness and skill.

R.I.B.A. FORM OF BUILDING CONTRACT

EXPLANATION OF CLAUSES

39. The only form of conditions of contract that has been formally adopted by the architects and builders in the British Isles is issued by the Royal Institute of British Architects, London. It was drawn up by representatives of the Institute and the National Federation of Building Trade Employers of Great Britain and Ireland, and copies are sold by the R.I.B.A. for one shilling each. This form is used in England, Scotland, and Ireland in cases where it is desired to have anything more than a short agreement. The only alternative in a large contract is to have a form of contract drawn up by a solicitor, who, in settling conditions with the builder or his solicitor, will get the architect to advise on the technical part of the contract. The R.I.B.A. form is drawn up with a view to meet all ordinary questions arising, or likely to arise, on a contract for the erection of a building, but it does not attempt to deal with special circumstances. Where these arise, it will be wise of the architect to seek the assistance of a solicitor. Although copyrighted, by the courtesy of the Council of the Institute a form with the blanks filled in is given in facsimile toward the end of this Section.

40. There are two types of the R.I.B.A. conditions of contract, one applicable where quantities are made part of the contract and one where they are not. The conditions having been agreed between the representatives of all parties, they may be taken as affording fair protection to the employer. They also protect the builder against unreasonable treatment by the architect or delay in payment by the employer, while they protect the architect, who is in some cases the agent of the employer, and in other instances the arbitrator to settle questions between the two parties. That this form may be thoroughly understood, it is analyzed, and each clause explained, so that the architect may know the means to be taken to ensure the proper carrying out of the contract.

On the first page of this form there is a footnote, stating that the words *s and co-partners* should be added to the word Builder, if such is the fact. The letter *s* should be added in all cases where the name of the contracting firm includes that of more than one person. The insertion of the words *and co-partners* is not general in practice, but it correctly applies to all cases other than those of a limited company.

41. Provision as to Carrying Out the Work.—Clause 1 provides that the work shall be carried out in accordance with the signed drawings and specification and to the reasonable satisfaction of the architect. It further deals with the contractor's action with regard to work which he may consider to be extra on the contract, and provides for the settlement of any dispute on this subject being by arbitration. It gives to the architect the custody of the contract drawings and papers.

42. Drawings and Specification.—Clause 2 states what drawings and papers the architect is required to furnish to the contractor for his own use free of charge, and deals with the supply of detail drawings, and lays an obligation on the contractor to keep all drawings and papers on the works and return them to the architect on completion of the contract.

43. Submission of Priced Bill of Quantities.—Clause 3 binds the contractor, on the signing of the contract, to furnish the architect with a fully priced bill of quantities for his own use or that of the quantity surveyor. It is not unusual in practice to give the contractor 7 days from the signing of the contract in which to deposit this priced copy with the architect. Sometimes this priced copy is required to be deposited under seal, with the view that it shall not be referred to until a question in dispute occurs. But such an arrangement deprives the architect of the priced bill as a reference in considering questions of proposed variations, and in certifying from time to time as to the value of the work which has been executed.

44. Contractor to Provide Everything Necessary.—Clause 4 binds the contractor to provide everything necessary for the

proper execution of the work, and gives the architect power, in the case of any discrepancy in the drawings, or between the drawings and specification, to decide which shall be followed. It should be observed that the decision placed in the hands of the architect in this clause is absolute, and not subject to revision by the arbitrator mentioned in Clause 32.

45. Compliance With Acts and Regulations.—Clause 5 provides that the contractor shall conform to the provisions of all Acts of Parliament, and to the regulations and by-laws of local authorities, and of water and lighting companies, and shall give to the architect written notice of any variations from the drawings and specification necessitated by such conformity, and shall apply for his instructions thereon. But the contractor is authorized to proceed with the work, varying it so as to comply with the law or regulation, if he does not then in due course receive the required instructions. The clause further provides that the contractor shall give all requisite notices to the local authority and pay all fees which are payable. There is no time specified in this clause during which the architect must reply to the contractor as regards variations alleged to be necessitated, and this is rather a serious omission, as it may give the contractor the opportunity to comply with some requirement, not possible to be justified by law, which will be more to his advantage than a strict compliance with the contract.

46. Contractor to Set Out Works.—Clause 6 provides that the contractor shall set out the works, and amend at his own cost any errors arising from inaccurate setting out, unless the architect shall decide to the contrary. The careful dimensioning of the drawings throughout will greatly assist the contractor to obtain an accurate setting out, and will be of service to the architect in checking the contractor's work.

47. Materials and Workmanship.—Clause 7 provides that the material and workmanship shall be of the respective kinds described in the specification, and that the contractor shall, on the request of the architect, furnish him with vouchers to prove that the materials are as specified. The first part of this clause

appears to be intended to supplement and amplify the first part of Clause 1; the second part, giving the architect the right of seeing vouchers, is of the utmost importance to him.

48. General Foreman.—Clause 8 provides that the contractor shall keep constantly on the works a competent general foreman, who is to be considered the representative of the contractor in the matter of receiving directions and explanations.

49. Dismissal of Incompetent Workmen.—Clause 9 gives power to the architect to require the contractor to dismiss immediately any person employed on the works who, in the architect's opinion, may be incompetent or misconduct himself. The decision as to the competency of all workmen, including the general foreman, would thus appear to rest with the architect, and his action under this clause cannot be a matter of reference to the arbitrator mentioned in Clause 32.

50. Right of Access to Works.—Clause 10 gives the architect, or any person authorized by him, a right of access at all reasonable times to the works and to the contractor's workshops or other places where work is being prepared for the building.

51. Clerk of Works.—Clause 11 relates to the clerk of works and defines his status, and binds the contractor to give him every facility for examining work and material.

52. Authorized Variations.—Clause 12 provides for authorized variations from the drawings and specification and for variations under Clause 5. Except under the provisions of Clause 5 the contractor is not allowed to make any variation which is not authorized by the architect. Proof of authorization is by any writing or drawing signed by the architect, or by written approval given subsequently by him. The fact that the only unauthorized variations are those which may be carried out by the contractor under Clause 5 emphasizes the great importance of this clause.

53. Question of Quantities in Relation to Contract.—Clause 12a, which is omitted from the list of conditions where quantities do not form part of the contract, provides that errors in the bills of

quantities shall be rectified and that such rectification shall be a variation of the contract. This clause lays the employer open to large claims if the quantities should be badly prepared. In this case it would appear that the employer would be liable to pay the builder sums which he could not recover from the quantity surveyor, unless it could be conclusively proved that the latter had been guilty of negligence. The architect should therefore consider very carefully whether he will make the quantities part of the contract or whether he will omit this clause, and for the purposes of the contract treat the bill of quantities merely as a schedule of prices to be taken as a basis in the valuation of extras and omissions. In case he proposes to treat the bill of quantities simply as a schedule of prices, he should make it plain to all contractors invited to tender that he is going to do so, to give them an opportunity to check the figures of the quantity surveyor, if they so desire.

54. Valuation of Variations.—Clause 13 deals with variations, and provides that they shall not vitiate the contract, but that all authorized extras and omissions shall be measured and valued either by the architect or the quantity surveyor. It also provides when and how day work shall be allowed.

55. Fees for Quantities.—Clause 14 provides that the fees and expenses of the quantity surveyor shall be paid by the contractor immediately after he has received payment of any certificate in which they are included. It also provides that the further fees for settling variations and omissions shall be paid by the contractor before the issue of the final certificate, and enables the employer, in default of payment by the contractor and on the certificate of the architect, to pay the quantity surveyor himself and deduct the amount from the money due to the contractor. As a rule, the amount of the quantity surveyor's account is included in the first certificate. Where, as is usually the case, the employer himself does not pay the quantity surveyor, a clause to this effect is necessary; but where the architect himself takes off the quantities and charges the employer directly for them, or where the employer can be induced to pay the quantity surveyor himself, this clause is not required.

56. Materials Not to be Removed.—Clause 15 provides that when the contractor has received payment of any certificate in which the architect shall have stated that he has taken into account the value of any unfixed materials on the site, such materials shall become the property of the employer and shall not be removed by the contractor. Unfixed material is in so many cases taken into account by architects, that in fairness to the contractor it will be well to include it always in certificates, unless there is some special reason rendering the adoption of this course undesirable.

57. Unsound Work and Materials.—Clause 16 gives the architect power to order the contractor to remove from the works any materials which, in his opinion, are not in accordance with the drawings and specification or instructions, and to substitute proper materials and re-execute the work. It further provides that, if the contractor fails to do so, the employer may employ other persons to do the work, and all expenses may be deducted from money due to the contractor or may be recoverable from him. The action of the architect under this clause is not a matter of reference to the arbitrator mentioned in Clause 32. The architect has absolute power to reject either material or workmanship which is unsatisfactory. Should the contractor not carry out the architect's instructions to remove either defective material or workmanship, it is well to give him formal notice in writing, served either by hand or by registered letter, requiring him to do so within a certain specified reasonable time, as it gives the contractor the opportunity of reconsidering his action, and may thus lead to a settlement of the dispute ; while, on the other hand, if the contractor persists in his obstinacy and the whole matter comes to be the subject of an action at law, it is of great benefit to the architect if it is evident that he has made every reasonable effort to avoid a dispute.

58. Defects Subsequent to Completion.—Clause 17 deals with defects, shrinkage, or other faults which may appear within a specified time after the completion of the works, if arising, in the opinion of the architect, from materials and workmanship not in accordance with the drawings and specification or his

instructions. It also deals with any damage by frost to pointing which may occur during the same time. The contractor is required to amend such defects within a specified reasonable time, on request in writing by the architect, and, if he does not do so, the employer may employ and pay other persons to remedy the defects, and may deduct the cost from money due to the contractor. It also provides that, where work done by a subcontractor is similarly defective, it shall be made good by the contractor. The architect's decision under this clause would appear to be subject to reference to the arbitrator mentioned in Clause 32, although it is difficult to understand why this should be so any more than his decision in matters dealt with in Clause 16.

59. Opening Up of Work.—Clause 18 provides for the opening up, at the request of the architect, of work already covered by the contractor. It places the cost of effecting such opening upon the contractor, if the covering up is contrary to the architect's instructions, or if the work on being opened up is found to be not in accordance with the drawings and specification or instructions; but it makes the employer liable for the cost in all other cases. There is also a provision, in the case of foundations and any other urgent work which when so opened up requires immediate attention, that within a reasonable time after receipt of notice from the contractor that the work has been opened up the architect shall make inspection of it. If he does not, the contractor is at liberty to cover it up and can only be obliged to open it up again for inspection at the expense of the employer. The exercise of the architect's right to have any work opened up is not a matter which can be the subject of a reference to the arbitrator. It seems a pity that no definite time is given for the architect to make his inspection under the latter part of this clause, the expression a "reasonable time" is too indefinite.

60. Assigning and Subletting.—Clause 19 states that the contractor shall not, without the written consent of the architect, assign the agreement, that is, the contract for carrying out the work, or sublet any portion of the work. The architect's

decision in these cases is conclusive, as reference to the arbitrator is not possible under this clause. It is difficult to conceive any circumstances which would induce the architect to consent to an assignment of the contract except bankruptcy on the part of the contractor. As to subletting, there is so much of it done by builders in various parts of the British Isles that it is difficult, if not impossible, for the architect to insist on this clause being kept to the letter. A strict interpretation of the clause would not even permit a contractor to let his brickwork by the rod, and it would forbid the subletting of the excavation for cellars, which, in large towns, is almost invariably a separate business in itself. The architect must take care that such important matters as masonry, plumbing, zincwork, concrete steps and pavings, joinery, iron and steel construction, asphalt work, slating, and glazing are in proper hands; but it would be making his position unduly onerous if he were to concern himself to see that every man employed on the work is paid by the day and not by the piece. As regards the important matter of specialists' work, unless the invitation to tender is limited to builders in whom the architect has thorough confidence, it is as well for him to settle all such questions before tenders are invited. He can do this by getting preliminary tenders for each of the special trades, and then put the amounts, with such additions as he may think fit to provide for contingencies, into the general specification as provisional sums, or prime cost items. As to the less important items he must rely on his own supervision, or that of the clerk of works, to see that his client gets what is intended.

61. Position of Specialist Tradesmen.—Clause 20 provides that all specialists, particular tradesmen, and others executing work or supplying material for which provision has been made in the specification, who may be nominated by the architect, shall be subcontractors employed by the contractor. But if (1) the contractor shall make an objection to any such person which the architect shall consider to be reasonable; or if (2) any such person will not enter into a proper contract with the contractor on similar terms and conditions to those contained in the

contract between the employer and contractor, then such person shall not be employed as a subcontractor on the works. The importance of the provision that the contractor shall employ all subcontractors and thus be entirely responsible for the whole of the work can hardly be overestimated.

62. Contractor Responsible for Damage.—Clause 21 makes the contractor responsible for all structural and decorative damage to property and for injury caused by the works or workmen to persons, animals, or things. It also makes him liable for any claim for workmen's compensation made by any person in the contractor's employ. It further makes the contractor responsible for all injury to the buildings caused by weather, and binds him to make good all such damage and thoroughly complete the whole of the works.

63. Insurance of Works.—Clause 22 deals with the insurance of the works against loss or damage by fire, and is in two parts: one applicable to the case of a new building, where the contractor insures; and the other applicable to an existing building that is being altered, where the employer undertakes the insurance. In the latter case it gives power after a fire for the contract to be determined, so far as it relates to any subsequent work, at the option of either party, if, in the opinion of the arbitrator appointed under Clause 32, such determination is just and equitable. Some contractors keep a floating policy on all the works they have in hand. If the architect thinks fit to allow this to cover the work with which he is concerned, he should ascertain from the insurance company if the policy held by the contractor covers the work which is the subject of the contract. He should then give the insurance company formal notice that his client has an interest in the property insured, as, after receiving such a notice, the insurance company is legally bound to expend the insurance money on reinstating the building, unless such notice is withdrawn by the person interested.

64. Possession of Site by Contractor.—Clause 23 states on what date possession of the site shall be given to the contractor, and provides that he shall begin the works forthwith and proceed

with them regularly, and, except for papering, painting, and any other work which it seems to the architect desirable to delay, shall complete them by a certain specified date, subject to what is provided in Clause 25 as to extension of time. The architect must make himself quite certain that possession can be given on the day stated, and that such possession includes the whole of the site of the new works. It is usual, when the site is covered with old buildings, to deal with these by means of a separate contract for the clearing of the site. The architect must assure himself that any contract entered into for this purpose, or any agreement for tenancy, is at an end prior to the date on which he decides that the contractor shall obtain possession. In the event of portions of the site being subject to easements of way, it seems desirable that a reservation should be made to this clause by a paragraph setting out the easements in question, a plan, if necessary, being appended showing what part of the site they affect.

65. Damages for Non-Completion of Work.—Clause 24 places the contractor under damages for non-completion of the works in accordance with the preceding clause; but damages are not incurred unless the architect certifies in writing that the works could reasonably have been completed by the date laid down or within the subsequently extended time, for the architect has power to make an extension of the time mentioned in the contract.

66. Extension of Time.—Clause 25 binds the architect in certain circumstances, and for certain reasons which are set out, to make a fair and reasonable extension of time for the completion of the contract. It also binds the contractor to use his best endeavours to prevent delay and to do all that may reasonably be required, to the satisfaction of the architect, to proceed with the works. The reasons which the architect is bound to take into consideration are delay to the works by:

1. Force majeure.—The principal application of this term is when the contractor is restrained by order of court of law.

2. Exceptionally inclement weather.—The architect should make a practice of noting at each visit if the works are stopped

or materially delayed by inclement weather, or he should get his clerk of works to keep accurate observation and notify him from time to time. The question of what constitutes exceptionally inclement weather depends a great deal on the time of year. A contractor cannot expect that his men will be able to work as many days a week during December, January, and February, as in June, July, and August.

3. Instructions from the architect in consequence of proceedings taken or disputes with adjoining or neighbouring owners.—It will be observed that this reason only allows of delay by instructions from the architect. If the contractor chooses to stop the works because he is threatened by other parties, the architect is not bound to take his action into consideration.

4. The works or delay of other contractors or tradesmen engaged or nominated by the employer or architect, and not referred to in the specification.—It is clearly not the intention of the contract that the delays due to the subcontractors referred to in the specification should be made an excuse by the contractor.

5. Authorized extras or additions.—It may be thought that the architect would be entitled to set off against any extras such omissions which have in his opinion reduced the time necessary for the completion of the work; but this is not specifically stated, although probably the arbitrator, to whose final decision the matter would come in the event of a dispute, might allow this procedure.

6. In consequence of any notice reasonably given by the contractor under Clause 1 of the contract.—It would appear that the notice given by the contractor is to be the cause of the delay, and not the works which as extras would come under the last paragraph. The only conceivable delay which could occur would be due to correspondence between the architect and the contractor, or in consequence of the architect's slowness in making up his mind, neither of which, if the architect acts in a businesslike manner, need cause any appreciable delay in the conduct of the works.

7. Any local combination of workmen or strike or lock-out affecting any of the building trades.—In case of such strike or

lock-out the contractor is required, as soon as may be, to give to the architect written notice thereof. There being a general requirement at the end of the clause to the effect that the contractor is to use his best endeavours to prevent delay, it may be questioned whether a contractor who might refuse to accede to a reasonable offer which would lead to the abandonment of the strike would not be contravening this requirement, and consequently be unentitled to an extension of time equivalent to the whole time occupied by the strike.

8. The contractor not having received in due time necessary instructions from the architect for which he shall have specifically applied in writing.—Referring to Clause 5 of the contract, it will be found that it specifically states that where the contractor does not receive in due time instructions as to the matters dealt with under that clause he shall proceed with the work. Thus, it would appear that no delay can be alleged as to the matters dealt with by that clause, and they cannot enter into the decision of the architect or arbitrator. The only remaining items are detail drawings and directions requested of the architect during the progress of the works, and it is essential in his client's interest that the architect should keep to the provision of Clause 2 with regard to the former, and decide with promptness on the latter.

67. Procedure in Case of Contractor's Delay.—Clause 26 is intended to protect the employer from any delay on the part of the contractor. It provides that if for any other reason than any legal restraint on the employer which prevents the continuance of the works, or any of the causes mentioned in Clause 25, or in case of a certificate being withheld or not paid when due, he shall suspend the execution of the works. Or if, in the opinion of the architect, the contractor shall neglect or fail to proceed with due diligence, or if he shall more than once make default as regards the removal of unsound materials or work as referred to in Clause 16, the employer, through the architect, has the power to give him notice in writing that the works must be proceeded with in a reasonable manner and with reasonable despatch. The notice should state that it is given under Clause 26, and some act or default on the part of the contractor, which is a ground for

the giving of this notice, must be specified in it. After the notice is given, the contractor shall not be at liberty to remove from the works or the site, or from land contiguous thereto, any plant or materials belonging to him which have been placed thereon for the purposes of the works, for the employer has a lien on such plant and materials. This lien, however, will lapse if the employer does not, within 31 days of the date of such notice, enter upon and take possession of such plant and materials.

68. If the contractor does not proceed with the works within the specified number of days from the date of the notice, the employer may take possession of the plant and materials. He should be advised by the architect as to the steps necessary to complete the works without undue delay or expense, and may use the plant and materials or authorize other persons to use them for carrying on the work of completing the building. The employer has the right also to exclude the contractor from the works, with the reservation that he or his nominee may enter to inspect and measure the works. The clause further deals with the expense of completing the work and the disposal of the plant and materials after the works are complete. It also provides that any notice given to the contractor under this clause shall be given by leaving it at his place of business or by sending a registered letter to him at that address. The contractor is so amply safeguarded in this clause that if an employer ever succeeds in possessing himself of the plant and excluding the contractor from the works he will have had very good reason for his action. Contractors generally ask for 14 days in which to proceed with the works after the notice has been given, but it is not wise to concede more than 10 days, as this gives the employer only 3 weeks in which to enter upon the works and site and take possession of the plant.

69. The clause terminating the contract on the bankruptcy of the contractor, which was once put in all building contracts, has been dropped. Clause 26, therefore, must be taken as being considered by the Royal Institute of British Architects a proper substitute for it. No doubt this clause gives the employer powers against the contractor himself, but it does not

specifically allow for a trustee in bankruptcy being placed in the position of contractor. It is therefore necessary for the architect to satisfy himself of the financial stability of the contractor before concluding the contract, or he should insist on the contractor giving bonds for a substantial amount, so as to ensure the completion of the works. It is to be presumed that the clause which binds the contractor not to assign the contract will apply to any assignment made by a contractor to a liquidator for the benefit of his creditors, but there is no provision in the contract itself that makes it cease and determine on violation of its conditions.

70. Prime Cost.—Clause 27 deals with the question of **prime cost,** or P.C. prices, and states in precise language that they refer to sums paid to the merchant after deducting all trade discount, but not deducting discount for cash. The question of P.C. values is constantly occurring. The builder usually contends, unless it can be plainly shown that such is directly contrary to the specification or contract, that P.C. value means list price values, and that he is entitled to all trade discounts, which amount to 40 per cent. on the list price of many articles. It is unfortunate that manufacturers and merchants think it necessary to issue catalogues which state prices at so much more than they really are, as builders have been known to put such catalogues before their employers, giving them to understand that the prices stated are approximately the prices paid. When an architect has to deal with accounts in which articles have been ordered from such lists, he must, in justice to his client, find out what the discounts are, a course of action which often involves a great deal of trouble. The clause which gives the architect the right to demand the producing of vouchers by the contractor, to prove that the materials are such as specified, is of considerable importance in connection with this question of trade discount.

71. Provisional Sums.—Clause 28 provides that **provisional sums** mentioned in the specification and quantities for materials or special work shall be paid under direction of the architect, either by the contractor without deduction or discount, or by

the employer without prejudice to the contractor's rights under Clause 20. This refers both to amount and time and to such person as the architect may direct. Provision is made for ascertaining the value of work done either by the contractor or the other special tradesman in respect of the provisional amounts, and for allowing the contractor a proper profit thereon. It is further provided that any damages payable by a sub-contractor shall go to the contractor and not to the employer. It is to be noted that the provisional sums when paid by the contractor to the special tradesmen are to be paid without discount or deduction. Thus, the builder almost invariably puts a sum against such items in the quantities as his profit on the work covered by the provisional sums.

72. Facilities for Other Tradesmen.—Clause 29 provides that the contractor shall permit the execution of work by any other contractor or tradesman who may be engaged by the employer.

73. Method of Payment.—Clause 30 states that payments shall be made only when the architect certifies that, in his opinion, the sum desired is due. At first, the contractor is to receive only a certain percentage of the value of the work done. When the value of the work done, but not fully paid for, reaches a fixed sum, all subsequent certificates shall be for the full amount due. When the works are practically completed, the contractor is entitled to payment of a specified sum, generally one-half of the balance, and is entitled to the remainder of the balance at the expiration of a stated time, or when the works shall be finally completed and all defects made good in accordance with the contract, whichever shall last happen. This clause also provides that no certificate issued by the architect shall be considered conclusive evidence of the sufficiency of any work or materials to which it relates, and that, if the architect requires it, the contractor, when he applies for a certificate, shall furnish an approximate statement of the work executed. This arrangement as to payment is somewhat complicated, and should not be entered into for contracts under about £4,000. The usual percentage of the value of the work required to be certified is 80, and 14 days is generally a sufficient time to allow

the employer to pay the amount certified. It is very desirable, in practice, to inform the employer as soon as a request for a certificate is received from the builder, and at the same time to state approximately what the probable amount of the certificate will be. Unless the architect has taken out the quantities himself, he will often find it desirable to consult with the quantity surveyor before issuing his certificate as to the value of the work which has been executed.

74. Procedure in Case of Non-Payment.—Clause 31 provides that should the employer fail to pay the sums certified by the architect, the contractor is to give written notice to the employer of the failure to pay, and is entitled to determine the contract by notice in writing to the architect in the event of any of the following contingencies :

1. Non-payment within a period of a specified number of days from the date of the delivery at the employer's address of a registered letter containing a notice of non-payment of the amount certified by the architect.

2. Bankruptcy, or the filing of a petition to liquidate his affairs, on the part of the employer, if the trustee in bankruptcy shall repudiate the contract, or if the trustee shall be unable to show within a specified number of days, to the reasonable satisfaction of the contractor, his ability to carry out the contract and to make all payments due or to become due thereunder.

3. The suspension of the works for a stated number of months under the order of the architect or any court of law.

On such termination of the contract, the contractor shall be entitled to payment by the employer for all plant or material purchased or prepared for the purpose of the contract, the rates contained in the contractor's original estimate, or rates proportionate thereto, forming the basis of the determination of the amount payable to the contractor. The term of 10 days from the notice of non-payment, within which term payment is required to be made, is generally sufficient to protect the employer. Forty days is generally enough for tne trustee in bankruptcy to show his ability to carry out the contract, if he is at all likely to do so.

75. Arbitration.—Clause 32 is the very important arbitration clause. It provides for the settling of any dispute or difference between the parties, either during the progress of the works or after the determination, abandonment, or breach of the contract, as to any of the following questions :

1. The construction of the contract.

2. Any matter or thing arising under the contract, except matters left to the sole discretion of the architect under Clauses 4, 9, 16, and 19, and the exercise by the architect under Clause 18 of the right to have any work opened up.

3. The withholding by the architect of any certificate to which the contractor may claim to be entitled.

Either party shall forthwith give to the other notice of such dispute or difference, and such dispute or difference is thereby referred to the arbitration of the person stated in the contract, whose decision shall be final and binding on the parties. It is further stated that, except as to the question of a certificate, a reference to arbitration shall not be dealt with until after the completion or alleged completion of the contract, unless with the consent in writing of the parties. The arbitrator is to have power to open up, review, and revise any certificate, opinion, decision, requisition, or notice, except in regard to the specified exceptions, and to determine all matters in dispute which shall be submitted to him and of which notice shall have been given, as if no such certificate, opinion, decision, requisition, or notice had been given. The costs of and incidental to the reference and the award shall be in the discretion of the arbitrator, who may determine the amount of them, or may direct them to be taxed either as between solicitor and client or between party and party, and shall direct by whom they are to be paid. It is specifically provided that this clause is a submission to arbitration within the meaning of the Arbitration Act, 1889.

76. It would appear that no question can be gone into by the arbitrator unless one party has given notice to the other of the dispute or difference which has arisen between them forthwith, that is, as soon as practicable after such difference arises. The contract, however, does not provide that such

notice shall be in writing, which is a serious omission that should be remedied by the architect by obtaining the insertion of the words *in writing*, and getting them initialled by both parties, before the contract is signed. This will prevent either party bringing up for revision by the arbitrator some matter which, before occasion for difference arose, had been verbally settled on give-and-take principles by the parties, and the opening up of which might, on account of the time which had elapsed or other reason, place the other party in a position of disadvantage. No question as to a certificate should arise, for, if a quantity surveyor is employed, the architect will, if in doubt as to the amount to be certified, get him to advise, and he will be the architect's witness, if the contractor is so dissatisfied as to bring the matter before the arbitrator.

77. In practically every case no reference to the arbitrator need be made until the completion or practical completion of the work. This prevents either party bringing up matters in dispute without due consideration, or until all such matters can be considered generally and in relation to one another. In case of a reference, the architect should not allow his employer to be in a position of inferiority as to the persons representing him; for instance, he must not allow a solicitor or barrister to address the arbitrator or examine witnesses on behalf of the contractor without endeavouring to ensure that his employer is similarly represented.

78. **Summary of R.I.B.A. Form.**—It cannot be said that the Royal Institute of British Architects' conditions of contract bear with undue harshness on the contractor; in fact, if there is any fault to be found with them, it is that the architect's decision can be made, in too many matters, the subject of revision by the arbitrator. It is scarcely consistent that, while the architect has unrestricted power to order the removal of improper work, under Clause 16, his powers as to defects after completion, under Clause 17, should be subject to revision by the arbitrator. It is most difficult to understand why, in this case, reference to the arbitrator has been made possible.

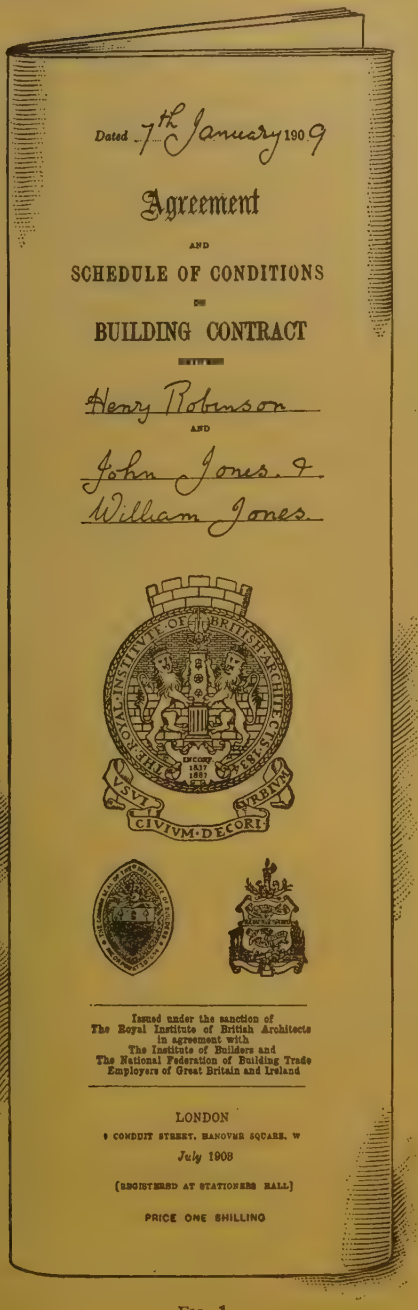

FIG. 1

SPECIMEN CONTRACT R.I.B.A. FORM

79. The following form, consisting of Articles of Agreement and the schedule of conditions of contract, is applicable where quantities do not form part of the contract. Where quantities are included, Clause 4 in the Articles of Agreement is omitted, and there is inserted a Clause 12a in the schedule, which is as follows: *Should any error appear in the bills of quantities other than in the contractor's prices and calculations, it shall be rectified, and such rectification shall constitute a variation of the contract, and shall be dealt with as hereinafter provided.*

The blanks in the schedule have been filled in for a contract of about £10,000. Fig. 1 shows the agreement in its folded form with the endorsement written on the back.

Articles of Agreement made the 7th day of January 1909

Stamp to be affixed here.

BETWEEN Henry Robinson
of Hillcroft Ditchington
in the County of Middlesex
(hereinafter called "the Employer") of the one part and
John Jones
of 16 John Street, Wellfield
and William Jones
of 16 John Street, Wellfield in the
County of Buckinghamshire Builder* s
(hereinafter called "the Contractor") of the other part. WHEREAS the Employer is
desirous of† erecting a factory
at 22 Canal Bank Wellfield Buckinghamshire and has caused Drawings
and a Specification describing the work to be done to be prepared by Walter
Smith of 30 Grays Inn Square
London W.C., his Architect: AND WHEREAS the said Drawings numbered 1 to
12 inclusive and the Specification marked "A" have been signed by or
on behalf of the parties hereto: AND WHEREAS the Contractor has agreed to execute upon
and subject to the Conditions set forth in the Schedule hereto (hereinafter referred to
as "the said Conditions") the works shown upon the said Drawings and described in
the said Specification for the sum of ten Thousand five Hundred
and twenty pounds (£10520)

NOW IT IS HEREBY AGREED AS FOLLOWS:—

1. In consideration of the sum of ten thousand five hundred
and twenty pounds (£10520) to be paid at the times and in the
manner set forth in the said Conditions, the Contractor will upon and subject to the said
Conditions execute and complete the works shown upon the said Drawings and described in the
said Specification

2. The Employer will pay the Contractor the said sum of ten thousand five
hundred and twenty pounds (£10520)
or such other sum as shall become payable hereunder at the times and in the manner specified
in the said Conditions.

3. The term "the Architect" in the said Conditions shall mean the said Walter
Smith or, in the event of his death or ceasing to be the
Architect for the purpose of this Contract, such other person as shall be nominated for that
purpose by the Employer, not being a person to whom the Contractor shall object for

* Insert "s and co-partners" if such is the fact. † State nature of intended works.

(2)

reasons considered to be sufficient by the Arbitrator mentioned in the said Conditions. Provided always that no person subsequently appointed to be Architect under this Contract shall be entitled to disregard or overrule any decision or approval or direction given or expressed by the Architect for the time being.

4. Any reference in the said Conditions to the Bills of Quantities shall not have the effect of constituting them part of this Contract.

5. The said Conditions shall be read and construed as forming part of this Agreement, and the parties hereto will respectively abide by and submit themselves to the conditions and stipulations and perform the agreements on their parts respectively in such Conditions contained.

As witness our hands this 1st day of January 1909

Signed by the said

Henry Robinson

Henry Robinson

in the presence of

Andrew Brown, architects assistant

30 Grays Inn Square WC

Signed by the said

John Jones

William Jones

John Jones

William Jones

in the presence of

Andrew Brown, architects assistant

30 Grays Inn Square WC

SCHEDULE OF CONDITIONS OF CONTRACT.

Drawings and Specification.

1.—The works shall be carried out in accordance with the directions and to the reasonable satisfaction of the Architect, in accordance with the signed Drawings and Specification, and in accordance with such further drawings, details, instructions, directions, and explanations as may from time to time be given by the Architect. If the work shown on any such further drawings or details, or necessary to comply with any such instructions, directions, or explanations, be, in the opinion of the Contractor, extra to that comprised in the Contract, he shall, before proceeding with such work, give notice in writing to this effect to the Architect. In the event of the Architect and Contractor failing to agree as to whether or not there is any extra, and of the Architect deciding that the Contractor is to carry out the said work, the Contractor shall accordingly do so, and the question whether or not there is any extra, and if so the amount thereof, shall, failing agreement, be settled by the Arbitrator as provided in Clause 32, and the Contractor shall be paid accordingly. The Contract Drawings and Specification shall remain in the custody of the Architect, and shall be produced by him at his Office as and when required by the Employer or by the Contractor.

Copies of Drawings and Specification.

2.—One complete copy of all Drawings and of the Specification shall be furnished by the Architect free of cost to the Contractor for his own use. The Architect shall furnish to the Contractor, within Seven days after the receipt by him of a request for the same, any details which in the opinion of the Architect are necessary for the execution of any part of the work, such request to be made only within a reasonable time before it is necessary to execute such work in order to fulfil the Contract. Such copies and details shall be kept on the works until the completion thereof, and the Architect or his representative shall at all reasonable times have access to the same, and they shall be returned to the Architect by the Contractor on the completion of the Contract.

Copy of Estimate.

3.—The Contractor shall on the signing hereof furnish the Architect with a verified * ~~———————~~ copy of the original estimate for his sole use or that of the Surveyor appointed as in Clause 13 hereof, and for the purposes only of this Agreement.

Contractor to provide everything necessary.

4.—The Contractor shall provide everything necessary for the proper execution of the works according to the true intent and meaning of the Drawings and Specification taken together, whether the same may or may not be particularly shown on the Drawings or described in the Specification, provided that the same is reasonably to be inferred therefrom; and if the Contractor find any discrepancy in the Drawings, or between the Drawings and Specification, he shall immediately refer the same to the Architect, who shall decide which shall be followed. Figured dimensions are to be followed in preference to the scale.

Local and other Authorities; Notices, &c.

5.—The Contractor shall conform to the provisions of any Acts of Parliament relating to the works, and to the regulations and by-laws of any Local Authority, and of any Water and Lighting Companies with whose systems the structure is proposed to be connected, and shall, before making any variation from the Drawings or Specification that may be necessitated by so conforming, give to the Architect written notice, specifying the variation proposed to be made, and the reason for making it, and apply for instructions thereon. In case the Contractor shall not in due course receive such instructions, he shall proceed with the work, conforming to the provision, regulation, or by-law in question, and any variation so necessitated shall be dealt with under Clause 18.

* The word "scaled" to be inserted if so agreed.

The Contractor shall give all notices required by the said Acts, regulations, or by-laws to be given to any Local Authority, and pay all fees payable to any such Authority, or to any public officer in respect of the works.

Setting out of work.

6.—The Contractor shall set out the works, and during the progress of the building shall amend at his own cost any errors arising from inaccurate setting out, unless the Architect shall decide to the contrary.

Materials, &c., to conform to Specification.

7.—All materials and workmanship shall be of the respective kinds described in the Specification, and the Contractor shall upon the request of the Architect furnish him with vouchers to prove that the materials are such as are specified.

Foreman.

8.—The Contractor shall keep constantly on the works a competent general foreman, and any directions or explanations given by the Architect to such foreman shall be held to have been given to the Contractor.

Dismissal of workmen by Architect.

9.—The Contractor shall, on the request of the Architect, immediately dismiss from the works any person employed thereon by him who may, in the opinion of the Architect, be incompetent or misconduct himself, and such person shall not be again employed on the works without the permission of the Architect.

Access for Architect to Works.

10.—The Architect and any person authorised by him shall at all reasonable times have access to the works, and the Architect and his representatives shall at like times have access to the workshops of the Contractor or other places where work is being prepared for the building.

Clerk of Works.

11.—The Clerk of Works shall be considered to act solely as inspector and under the Architect, and the Contractor shall afford him every facility for examining the works and materials.

Variations and extras.

12.—The Contractor shall, when authorised by the Architect, or as provided by Clause 5, vary by way of extra or omission from the Drawings or Specification, such authorisation is to be sufficiently proved by any writing or drawing signed by the Architect or by any subsequent written approval by him, but the Contractor shall make no variation without such authorisation. No claim for an extra shall be allowed unless it shall have been executed under the provisions of Clause 5, or by the authority of the Architect as herein mentioned. Any such extra is hereinafter referred to as an authorised extra.

Price for extras; how ascertained.

13.—No variation shall vitiate the Contract; but all authorised extras for which a price may not have been previously agreed, and any omission which may have been made with the knowledge of the Architect, or without his knowledge, provided he subsequently give a written sanction to such omission, shall be measured and valued, as hereinafter provided, by * the Architect

———— , and a copy of the bill or statement of such measurement and valuation shall be given to the Contractor. The fees for so measuring and valuing the variations shall be added to the contract sum. If in the opinion of the Architect the work cannot be properly measured and valued, day work prices shall be allowed therefor, provided that vouchers specifying the time and materials employed shall have been delivered for verification to the Architect, or his nominee, at or before the expiration of the week following that in which such work shall have been done. The variations shall be valued at the rates contained in the Contractor's original estimate, or, where the same may not apply, at rates proportionate to the prices therein contained. The amount to be allowed on either side in respect of the variations so ascertained shall be added to or deducted from the contract sum as the case may be.

* Insert "the Architect," or the name of a Surveyor.

Bills of Quantities; expenses of.

*14.—The fees for the Bills of Quantities and the Surveyor's expenses (if any) stated therein shall be paid by the Contractor to the Surveyor named therein out of and immediately after receiving the amount of the certificate or certificates in which they shall be included. The fees chargeable under Clause 13 shall be paid by the Contractor before the issue by the Architect of the certificate for the final payment. If the Contractor fails or neglects to pay as herein provided, then the Employer shall be at liberty, and is hereby authorised, to do so on the certificate of the Architect, and the amount so paid by the Employer shall be deducted from the amount otherwise due to the Contractor.

Unfixed materials when taken into account to be property of Employer.

15.—When the Contractor shall have received payment of any certificate in which the Architect shall have stated that he has taken into account the value of any unfixed materials intended for the works, and placed by the Contractor thereon, or upon ground adjacent thereto, all such materials shall become the property of the Employer, and shall not be taken away, except for the purpose of being used on the building, without the written authority of the Architect; and the Contractor shall be liable for any loss of or damage to such materials.

Power to Architect to order removal of improper work.

16.—The Architect shall, during the progress of the works, have power to order in writing from time to time the removal from the works, within such reasonable time or times as may be specified in the order, of any materials which in the opinion of the Architect are not in accordance with the Specification or the instructions of the Architect, the substitution of proper materials, and the removal and proper re-execution of any work executed with materials or workmanship not in accordance with the Drawings and Specification or instructions; and the Contractor shall forthwith carry out such order at his own cost. In case of default on the part of the Contractor to carry out such order, the Employer shall have power to employ and pay other persons to carry out the same; and all expenses consequent thereon or incidental thereto shall be borne by the Contractor, and shall be recoverable from him by the Employer, or may be deducted by the Employer from any moneys due or that may become due to the Contractor.

Defects after completion.

17.—Any defects, shrinkage, or other faults which may appear within Six months from the completion of the works, arising in the opinion of the Architect from materials or workmanship not in accordance with the Drawings and Specification or the instructions of the Architect, or any damage to pointing by frost appearing within the like period, shall upon the directions in writing of the Architect, and within such reasonable time as shall be specified therein, be amended and made good by the Contractor at his own cost, unless the Architect shall decide that he ought to be paid for the same; and in case of default the Employer may employ and pay other persons to amend and make good such defects, shrinkage, or other faults or damage, and all expenses consequent thereon or incidental thereto shall be borne by the Contractor and shall be recoverable from him by the Employer, or may be deducted by the Employer from any moneys due or that may become due to the Contractor. Should any defective work have been done or material supplied by any sub-contractor employed on the works who has been nominated or approved by the Architect, as provided in Clause 20, the Contractor shall be liable to make good in the same manner as if such work or material had been done or supplied by the Contractor, and been subject to the provisions of this and the preceding clause.

Work to be opened up at request of Architect.

18.—The Contractor shall, at the request of the Architect, within such time as the Architect shall name, open for inspection any work covered up; and should the Contractor refuse or neglect to comply with such request, the Architect may employ other workmen to open up the same. If the said work has been covered up in contravention of the Architect's instructions, or if on being opened up it be found

* *Note:* In cases where the Surveyor is engaged by the Employer to be paid direct by him the first sentence of this clause will come out.

not in accordance with the Drawings and Specification or the instructions of the Architect, the expenses of opening and covering it up again, whether done by the Contractor or such other workmen, shall be borne by, and recoverable from, the Contractor, or may be deducted as aforesaid. If the work has not been covered up in contravention of such instructions, and be found in accordance with the said Drawings and Specification or instructions, then the expenses aforesaid shall be borne by the Employer and be added to the contract sum: provided always that in the case of foundations, or of any other urgent work so opened up and requiring immediate attention, the Architect shall, within a reasonable time after receipt of notice from the Contractor that the work has been so opened, make or cause the inspection thereof to be made, and at the expiration of such time, if such inspection shall not have been made, the Contractor may cover up the same, and shall not be required to open it up again for inspection except at the expense of the Employer.

Assignment or sub-letting.

19.—The Contractor shall not, without the written consent of the Architect, assign this Agreement or sublet any portion of the works.

Sub-Contractors.

20.—All specialists, merchants, tradesmen, or others executing any work, or supplying any goods for which prime cost prices or provisional sums are included in the Specification, who may at any time be nominated, selected or approved by the Architect are hereby declared to be sub-contractors employed by the Contractor; but no such sub-contractor shall be employed upon the works against whom the Contractor shall make what the Architect considers reasonable objection, or who will not enter into a contract with the Contractor upon terms and conditions consistent with those in this Contract, and securing the due performance and maintenance of the work supplied or executed by such sub-contractor, and indemnifying the Contractor against any claims arising out of the misuse by the sub-contractor or his workmen of any scaffold erected or plant employed by the Contractor, or that may be made against the Contractor in consequence of any act, omission, or default of the sub-contractor, his servants or agents, and against any liability under the Workmen's Compensation Act 1897, or any amendment thereof.

Damage to person and property.

21.—The Contractor shall be responsible for all structural and decorative damage to property, and for injury caused by the works or workmen to persons, animals, or things, and shall hold the Employer harmless in respect thereof, and also in respect of any claim made under the Workmen's Compensation Act 1897, or any amendment thereof, by any person in the employ of the Contractor. He shall also be responsible for all injuries caused to the buildings, the subject of this Contract, by frost or other inclemency of weather, and shall reinstate all damage caused by the same, and thoroughly complete the whole of the works.

Insurance.

22.—*(a) The Contractor shall insure the works, and keep them insured until they are delivered up, against loss or damage by fire, in an office to be approved by the Architect, in the joint names of the Employer and Contractor, for the full value of the works executed, and shall deposit with the Architect the policies and receipts for the premiums paid for such insurance; and in default the Employer may insure the works and deduct the premium paid from any moneys due or which may become due. All moneys received under any such policies are to be paid to the Contractor by instalments on the certificates of the Architect, and to be applied in or towards the rebuilding or reparation of the works destroyed or injured. The Contractor shall, as soon as the claim under the policy is settled, proceed with all due diligence with the rebuilding or reparation, and shall not be entitled to any payment in respect thereof other than the said moneys received, but such extension of the time hereinafter mentioned for completion shall be made as shall be just

* *Note:* In this clause division (*a*) applies to a new building, and division (*b*) to an existing building to be altered. (*a*) or (*b*) should be struck out to suit circumstances.

and reasonable. (*b*) ~~The whole building and the works executed under this Contract shall be at the sole risk~~ of the Employer as regards any loss or damage by fire, and in the event of any such loss or damage being so occasioned which affects the original building or structure in addition to the new work, the Contractor shall be entitled to receive from the Employer the full value of all work then executed and materials then delivered, calculated in the manner provided for by Clause 18 hereof, and this Contract, so far as it relates to any subsequent work, may at the option of either party be determined if in the opinion of the Arbitrator such determination shall be just and equitable.

Date of completion.

23.—Possession of the site (or premises) shall be given to the Contractor on or before the 14th day of January 1909. He shall begin the works immediately after such possession, shall regularly proceed with them, and shall complete the same (except painting and papering or other decorative work which in the opinion of the Architect it may be desirable to delay) by the 1st day of December 1909 subject nevertheless to the provisions for extension of time hereinafter contained.

Damages for non-completion.

24.—If the Contractor fail to complete the works by the date named in Clause 23, or within any extended time allowed by the Architect under these presents, and the Architect shall certify in writing that the works could reasonably have been completed by the said date, or within the said extended time, the Contractor shall pay or allow to the Employer the sum of twenty pounds sterling per* week ——— as liquidated and ascertained damages for every* week beyond the said date or extended time, as the case may be, during which the works shall remain unfinished, except as provided by Clause 23, and such damages may be deducted by the Employer from any moneys due to the Contractor.

Extension of time.

25.—If in the opinion of the Architect the works be delayed by *force majeure* or by reason of any exceptionally inclement weather, or by reason of instructions from the Architect in consequence of proceedings taken or threatened by or disputes with adjoining or neighbouring owners, or by the works or delay of other Contractors or tradesmen engaged or nominated by the Employer or the Architect, and not referred to in the Specification, or by reason of authorised extras or additions, or in consequence of any notice reasonably given by the Contractor in pursuance of Clause 1, or by reason of any local combination of workmen or strikes or lock-out affecting any of the Building trades, or in consequence of the Contractor not having received in due time necessary instructions from the Architect for which he shall have specifically applied in writing, the Architect shall make a fair and reasonable extension of time for completion in respect thereof. In case of such strike or lock-out the Contractor shall, as soon as may be, give to the Architect written notice thereof. But the Contractor shall nevertheless use his best endeavours to prevent delay, and shall do all that may reasonably be required to the satisfaction of the Architect to proceed with the works.

Suspension of works by Contractor.

26.—If the Contractor, except on account of any legal restraint upon the Employer preventing the continuance of the works, or on account of any of the causes mentioned in Clause 25, or in case of a certificate being withheld or not paid when due, shall suspend the works, or in the opinion of the Architect shall neglect or fail to proceed with due diligence in the performance of his part of the Contract, or if he shall more than once make default in the respects mentioned in Clause 16, the Employer by the Architect shall have power to give notice in writing to the Contractor requiring that the works be proceeded with in a reasonable manner and with reasonable dispatch. Such notice shall not be unreasonably or vexatiously given, and must signify that it purports to be a notice under the provisions of this clause, and must specify the act or default on the part of the Contractor upon which it is based. After such notice shall have been given, the Contractor shall not be at liberty to remove from the

* Insert "day" or "week" as may be agreed.

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site or works, or from any ground contiguous thereto, any plant or materials belonging to him which shall have been placed thereon for the purposes of the works; and the Employer shall have a lien upon all such plant and materials, to subsist from the date of such notice being given until the notice shall have been complied with. Provided always that such lien shall not under any circumstances subsist after the expiration of thirty-one days from the date of such notice being given unless the Employer shall have entered upon and taken possession of the works and site as hereinafter provided. If the Contractor shall fail for Seven days after such notice has been given to proceed with the works as therein prescribed, the Employer may enter upon and take possession of the works and site, and of all such plant and materials thereon (or on any ground contiguous thereto) intended to be used for the works, and all such materials as above mentioned shall thereupon become the property of the Employer absolutely, and the Employer shall retain and hold a lien upon all such plant until the works shall have been completed under the powers hereinafter conferred upon him. If the Employer shall exercise the above power he may engage any other person to complete the works, and exclude the Contractor, his agents and servants, from entry upon or access to the same, except that the Contractor or any one person nominated by him may have access at all reasonable times to inspect, survey, and measure the works. And the Employer shall take such steps as in the opinion of the Architect may be reasonably necessary for completing the works without undue delay or expense, using for that purpose the plant and materials above mentioned in so far as they are suitable and adapted to such use. Upon the completion of the works the Architect shall certify the amount of the expenses properly incurred consequent on and incidental to the default of the Contractor as aforesaid, and in completing the works by other persons. Should the amount so certified as the expenses properly incurred be less than the amount which would have been due to the Contractor upon the completion of the works by him, the difference shall be paid to the Contractor by the Employer, should the amount of the former exceed the latter, the difference shall be paid by the Contractor to the Employer. The Employer shall not be liable to make any further payment or compensation to the Contractor for or on account of the proper use of the plant for the completion of the works under the provisions hereinbefore contained other than such payment as is included in the contract price. After the works shall have been so completed by persons other than the Contractor under the provisions hereinbefore contained, the Employer shall give notice to the Contractor of such completion and may require him from time to time, before and after such completion, to remove his plant and all such materials as aforesaid as may not have been used in the completion of the works from the site. If such plant and materials are not removed within a reasonable time after notice shall have been given, the Employer may remove and sell the same, holding the proceeds, less the cost of the removal and sale, to the credit of the Contractor. Any notice to be given to the Contractor under this clause shall be given by leaving the same at the place of business of the Contractor, or by registered letter sent to him at that address.

"Prime Cost," meaning of.

27.—The words "Prime Cost" or the initials P.C. applied in the Specification to goods to be obtained and fixed by the Contractor, shall mean, unless otherwise stated in the Specification, the sum paid to the merchant after deducting all trade discount for such goods in the ordinary course of delivery, but not deducting discount for cash, and such sum shall be exclusive of special carriage, the cost of fixing, and Contractor's profit.

Provisional sums.

28.—The provisional sums mentioned in the Specification for materials to be supplied or for work to be performed by special artists or tradesmen, or for other works or fittings to the building, shall be paid and expended at such times and in

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such amounts and to and in favour of such persons as the Architect shall direct, and sums so expended shall be payable by the Contractor without discount or deduction, or (without prejudice to any rights of the Contractor existing under the Contract referred to in Clause No. 20) by the Employer to the said artists or tradesmen. The value of works which are executed by the Contractor in respect of provisional sums, or in additional works, shall be ascertained as provided by Clause 18. At the settlement of the accounts the amount paid by the Contractor to the said artists or tradesmen, and the said value of such works executed by the Contractor, shall be set against all such provisional sums or any sum provided for additional works, and the balance, after allowing *pro rata* for the Contractor's profits at the rates contained in the Contractor's original estimate, shall be added to or deducted from the contract sum, provided that in estimating the amounts paid as last herein provided no deductions shall be made by or on behalf of the Employer in respect of any damages paid by the sub-contractor to the Contractor, the intention being that the Contractor and not the Employer shall have the benefit of any such damages.

Artists, &c., engaged by Employer.

29.—The Contractor shall permit the execution of work by any other artists or tradesmen who may be engaged by the Employer.

Payment and Certificate.

30.—The Contractor shall be entitled under the certificates to be issued by the Architect to the Contractor, and within fourteen days of the date of each certificate, to payment by the Employer from time to time by instalments, when in the opinion of the Architect work to the value of one thousand pounds (£1000) (or less at the reasonable discretion of the Architect) has been executed in accordance with the Contract, at the rate of 50 per cent. of the value of work so executed in the building, until the balance retained in hand amounts to the sum of One thousand two hundred pounds (£1200) after which time the instalments shall be up to the full value of the work subsequently executed. The Contractor shall be entitled, under the Certificate to be issued by the Architect, to receive payment of Six hundred pounds (£600) being a part of the said sum of £1200 when the works are practically completed, and in like manner to payment of the balance within a further period of six months, or as soon after the expiration of such period of six months as the works shall have been finally completed, and all defects made good according to the true intent and meaning hereof, whichever shall last happen. The Architect shall issue his certificates in accordance with this clause. No certificate of the Architect shall be considered conclusive evidence as to the sufficiency of any work or materials to which it relates, nor shall it relieve the Contractor from his liability to make good all defects as provided by this Agreement. The Contractor when applying for a certificate shall, if required, as far as practicable, furnish to the Architect an approximate statement of the work executed, based on the original estimate.

Non-payment by Employer.

31.—Should the Employer not pay the Contractor any sum certified by the Architect within the times respectively named in Clause 30, the Contractor shall give written notice to the Employer of the non-payment, and should the Employer not pay any such sum within the period of seven days from the date of delivery of such notice at the Employer's address or sent to him there in the ordinary course of post by registered letter, or if the Employer shall become bankrupt or file any petition for liquidation of his affairs, and if his Trustee in Bankruptcy shall repudiate this Contract, or if the Trustee shall be unable to show within forty

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_____days to the reasonable satisfaction of the Contractor his ability to carry out the Contract, and to make all payments due or to become due thereunder, or if the works be stopped for three months under an order of the Architect or any Court of Law, the Contractor shall be at liberty to determine the Contract by notice in writing to the Architect, and to recover from the Employer payment for all work executed and for any loss he may sustain upon any plant or material supplied or purchased or prepared for the purpose of the Contract. In arriving at the amount of such payment the rates contained in the Contractor's original estimate shall be followed, or, where the same may not apply, rates proportionate to the prices therein contained.

32.—Provided always that in case any dispute or difference shall arise between the Employer or the Architect on his behalf and the Contractor, either during the progress of the works or after the determination, abandonment, or breach of the Contract, as to the construction of the Contract or as to any matter or thing arising thereunder (except as to the matters left to the sole discretion of the Architect under Clauses 4, 9, 16, and 19, and the exercise by him under Clause 18 of the right to have any work opened up), or as to the withholding by the Architect of any certificate to which the Contractor may claim to be entitled, then either party shall forthwith give to the other notice of such dispute or difference, and such dispute or difference shall be and is hereby referred to the arbitration and final decision of Samuel Taylor of 86 Charing Cross. London W.C. _____ or, in the event of his death or unwillingness or inability to act, of Alfred Wilson of 72 Bride Lane Fleet Street London E. C. _____, or, in the event of his death or unwillingness or inability to act, of a person to be appointed on the request of either party by the President for the time being of The Royal Institute of British Architects, and the award of such Arbitrator shall be final and binding on the parties. Such reference, except on the question of certificate, shall not be opened until after the completion or alleged completion of the works, unless with the written consent of the Employer or Architect and the Contractor. The Arbitrator shall have power to open up, review, and revise any certificate, opinion, decision, requisition, or notice, save in regard to the said matters expressly excepted above, and to determine all matters in dispute which shall be submitted to him, and of which notice shall have been given as aforesaid, in the same manner as if no such certificate, opinion, decision, requisition, or notice had been given. Upon every or any such reference the costs of and incidental to the reference and award respectively shall be in the discretion of the Arbitrator, who may determine the amount thereof, or direct the same to be taxed as between solicitor and client or as between party and party, and shall direct by whom and to whom and in what manner the same shall be borne and paid. This submission shall be deemed to be a submission to arbitration within the meaning of the Arbitration Act 1889.

SHORT FORM OF CONTRACT

80. In the case of contracts of secondary importance, where the schedule of conditions of contract issued by the Royal Institute of British Architects is unnecessarily complex, a short form of contract such as is set out below is useful:

AGREEMENT made the ——— day of ———, One thousand nine hundred and ———, BETWEEN ——— of ———, in the County of ———, Builder (hereinafter called the Contractor), of the one part, and ——— of ———, in the County of ——— (hereinafter called the Employer), of the other part:

WHEREBY IT IS AGREED as follows:

The Contractor shall execute, maintain, and do the several works and things mentioned and described in the Specification hereto annexed and signed by the Contractor and by ———, of ———, in the County of ———, Architect of the Employer, and the Drawings referred to in such Specification, and upon the premises therein mentioned within the time or times and in consideration of the payments to be made to him by the Employer as therein mentioned, and shall in all respects be bound by and perform and observe and fulfil all the conditions, stipulations, and provisions expressed and contained in such Specification or Particulars and which are expressed or intended to be binding on and to be performed, observed, or fulfilled by the Contractor.

All work rendered necessary in consequence of the doing of the works (and alterations) hereby agreed upon shall be deemed to be included in and form part of this Contract, although not mentioned in the Specification, and no additional payment shall be made to the Contractor for the same.

No additional works shall be done by the Contractor except upon previous order in writing of the Architect, and should the same be done without such order the Contractor shall not be entitled to any additional payment for the same.

The Contractor shall completely finish the Works to the satisfaction of the Architect on or before the ——— day of ———, 19—.

In consideration of the premises the Employer shall pay to the Contractor the sum of ——— by the payments mentioned in the said Specification and in the manner therein mentioned, subject to the deductions, retentions, and abatements (if any) to be made therefrom as therein expressed, and shall in all respects be bound by and perform the conditions, stipulations, and provisions therein contained, and which are expressed or intended to be binding on and to be performed, observed, and fulfilled by the Employer.

The Parties hereto agree to submit any matter in connection with the said Works in dispute between them to the decision of _____, of _____, or in the event of his death, or inability to act, to _____, of _____, and that this is a submission to Arbitration within the meaning of the Arbitration Act, 1889.

As WITNESS the hands of the said Parties.

If it is desired that the architect shall be sole arbitrator, the last clause will read as follows:

The Parties agree that _____, of _____, the Architect, shall be sole Arbitrator in respect of any difference or dispute as to any matter or thing in connection with the said Works, and that his decision shall be final and binding on both of them.

81. The architect must bear in mind that if the short form just given is used, he must put into his specification a great deal of the substance of the conditions of contract which have been dealt with in the preceding pages; references must be included in the specification as to all matters such as prime-cost values, payments and how made, and many other questions which can be, and as a matter of fact generally are, dealt with in the specification, because that is the most convenient way of giving the contractor proper notice beforehand of the employer's requirements. All care taken in ensuring that the contractor fully understands the arrangements governing the execution of the required work will be amply rewarded by the absence of friction in carrying out the work.

VALUE OF ARBITRATION

82. The Arbitration Act.—The architect should familiarize himself with the terms of the Arbitration Act, 1889. The principle of arbitration is now generally accepted by all parties, and, even should there be no arbitration clause in a contract, a court of law will encourage the submission of the dispute to an arbitrator, and it is probably in the true interests of all parties that this should be done.

83. Architect as Sole Arbitrator.—It is unusual in small contracts for repairs and the erection of small buildings to put

a reference clause in the contract. In these cases the architect, with the consent of the builder, should make himself sole arbitrator. So long as he acts in good faith his decision cannot be impugned, and there is no reason why he should not rely on his own impartiality, if his employer and the builder are prepared to do so.

ARCHITECTS' CHARGES

THE R.I.B.A. SCHEDULE

84. Mention was made in Art. **11** of the schedule of charges which is issued by the Royal Institute of British Architects. Although this is not directly recognized as binding by law, it is accepted as representing the custom of the profession, and the fees allowed by the courts usually correspond with those therein specified. The schedule given in full below is inserted by kind permission of the Council of the R.I.B.A.

1. The usual remuneration for an architect's services,* except as hereinafter mentioned, is a commission of 5 per cent. on the total cost of works executed under his directions. Such total cost is to be valued as though executed by a builder with new materials. This commission is for the necessary preliminary conferences and sketches, approximate estimate when required, such, for instance, as may be obtained by cubing out the contents, the necessary general and detailed drawings, and specification, one set of tracings, duplicate specification, general superintendence of works, and examining and passing the accounts, exclusive of measuring and making out extras and omissions.

2. This commission does not include the payment for services rendered in connection with negotiations relating to the site or premises, or in supplying drawings to ground or other landlords, or in surveying the site or premises and taking levels, making arrangements in respect of party-walls and rights of light, or for drawings for and correspondence with local and other authorities, or for services consequent on the failure of builders to carry out the works, or for services in connection with litigation or arbitration, or in the measurement and valuation of extras and omissions. For such services additional charges proportionate to the trouble involved and time spent are made. The clerk of the works should be appointed by the architect, his salary being paid by the client.

* Schedule sanctioned by the Royal Institute of British Architects, confirmed at a General Conference of Architects of the United Kingdom, 1872, and revised by the Royal Institute, 1898.

3. In all works of less cost than £1,000, and in works requiring designs for furniture and fittings of buildings, or for their decoration with painting, mosaics, sculpture, stained glass, or other like works, and in cases of alterations and additions to buildings, 5 per cent. is not remunerative, and the architect's charge is regulated by special circumstances and conditions.

4. When several distinct buildings, being repetitions of one design, are erected at the same time from a single specification and one set of drawings and under one contract, the usual commission is charged on the cost of one such building, and a modified arrangement made in respect of the others; but this arrangement does not apply to the reduplication of parts in one building undertaking, in which case the full commission is charged on the total cost.

5. If the architect should have drawn out the approved design, with plans, elevations, sections, and specification, the charge is $2\frac{1}{2}$ per cent. on the estimated cost. If he should have procured tenders, in accordance with the instruction of his employer, the charge is $\frac{1}{2}$ per cent. in addition. Two and a half per cent. is charged upon any works originally included in the contract or tender, but subsequently omitted in execution. These charges are exclusive of the charge for taking out quantities. Preliminary sketches and interviews, where the drawings are not further proceeded with, are charged for according to the trouble involved and time expended.

6. Should the client, having approved the design and after the contract drawings have been prepared, require material alterations to be made, whether before or after the contract has been entered into, an extra charge is made in proportion to the time occupied in such alterations.

7. The architect is entitled during the progress of the works to payment by instalments on account at the rate of 5 per cent. on the amount of the certificates when granted, or, alternatively, on the signing of the contract, to half the commission on the amount thereof, and the remainder by instalments during their progress.

8. The charge per day depends upon an architect's professional position, the minimum charge being three guineas.

9. The charge for taking a plan of an estate, laying it out and arranging for building upon it, is regulated by the time, skill, and trouble involved.

10. For setting out an estate, the position of the proposed road or roads, taking levels, and preparing drawings for roads and sewers, applying for the sanction of local authorities, and supplying all necessary tracings for this purpose, the charge is 2 per cent. on the estimated cost. For subsequently preparing working drawings and specifications for roads and sewers, obtaining tenders, supplying one copy of drawings and specifications to the contractor, superintending works, examining and passing accounts, exclusive of measuring and valuing extras and omissions, the charge is 4 per cent. on the cost of works executed, in addition to the 2 per cent. previously mentioned.

11. For letting the several plots in ordinary cases the charge is a sum not exceeding a whole year's ground rent, but in respect of plots of great value a special arrangement must be made.

12. For approving plans submitted by the lessee, and for inspecting the buildings during their progress, so far as may be necessary to ensure the conditions being fulfilled, and certifying for lease, the charge is a percentage not exceeding $1\frac{1}{4}$ per cent. up to £5,000, and above that by special arrangement.

13. For valuing freehold, copyhold, or leasehold property the charge is: On £1,000, 1 per cent.; thence to £10,000, $\frac{1}{2}$ per cent.; above £10,000, $\frac{1}{4}$ per cent. on residue. In valuations for mortgage, if an advance is not made, one-third of the above scale. The minimum fee is three guineas.

14. For valuing and negotiating the settlement of claims under the Lands Clauses Consolidation Acts for the compulsory acquisition of property, the charge is on Ryde's Scale as follows:

On Amount of Settlement, Whether by Verdict, Award, or Otherwise.

Amount	Gs.	Amount	Gs.	Amount	Gs.	Amount	Gs.	Amount	Gs.	Amount	Gs.
£		£		£		£		£		£	
100	5	1,200	19	3,200	29	5,200	39	7,200	49	9,200	59
200	7	1,400	20	3,400	30	5,400	40	7,400	50	9,400	60
300	9	1,600	21	3,600	31	5,600	41	7,600	51	9,600	61
400	11	1,800	22	3,800	32	5,800	42	7,800	52	9,800	62
500	13	2,000	23	4,000	33	6,000	43	8,000	53	10,000	63
600	14	2,200	24	4,200	34	6,200	44	8,200	54	11,000	68
700	15	2,400	25	4,400	35	6,400	45	8,400	55	12,000	73
800	16	2,600	26	4,600	36	6,600	46	8,600	56	14,000	83
900	17	2,800	27	4,800	37	6,800	47	8,800	57	16,000	93
1,000	18	3,000	28	5,000	38	7,000	48	9,000	58	18,000	103
										20,000	113

Beyond this, Half-a-Guinea per cent.

The above scale is exclusive of attendances on juries or umpires, or at arbitrations, and also of expenses and preparation of plans.

15. For estimating dilapidations and furnishing or checking a schedule of same, the charge is 5 per cent. on the estimate, but in no case less than two guineas. For services in connection with settlement of claim by arbitration or otherwise, extra charges are made, under Clause 8.

16. For inspecting, reporting, and advising on the sanitary condition of premises, the charge must depend on the nature and extent of the services rendered.

17. In all cases travelling and other out-of-pocket expenses are paid by the client in addition to the fees. If the work is at such a distance as to lead to an exceptional expenditure of time in travelling, an additional charge may be made under Clause 8.

18. When an architect takes out and supplies to builders quantities on which to form estimates for executing his designs, he should do so with the concurrence of his client, and it is desirable that the architect should be paid by him rather than by the builder, the cost of such quantities not being included in the commission of 5 per cent.

BUILDING SUPERINTENDENCE

(PART 1)

MEASURING

INSTRUMENTS USED

INTRODUCTION

1. If, when superintending the erection of buildings, an architect is instructed to make certain alterations or additions to an existing building, or to pull down and erect a new building on the site, he must make a survey, or make plans, elevations, and sections, of the existing building and site by taking the necessary measurements and setting them out to scale on a drawing. He must then make the necessary alterations on these plans for the guidance of the builder. Should an architect be instructed to erect a building on an open site, he must by measuring and levelling make a plan, to scale, of the site and determine its levels before he can commence his working drawings.

2. Measuring and levelling are included under the general term **surveying,** which is used in a number of ways. When it refers to a specific operation or investigation necessary to ascertain accurately the quality and condition of existing buildings, it is known as *dilapidation surveying*. The ascertaining of the quantity and description of the various materials to be used in a proposed building is known as *quantity surveying*. The ascertaining of the dimensions, boundaries, and other topographical

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particulars of some building or part of the earth's surface is known as *land surveying*. The term surveying also includes the making of the plan or the drawing up of the account of such particulars. A knowledge of land surveying is necessary to the architect to enable him to determine accurately the boundaries, positions, extent, area, contour, or other particulars of a building or piece of land by measuring lines and angles, and then to represent the original object in a drawing to scale on paper.

3. When taking his measurements and plotting the results, an architect requires, besides the compasses, **T** square, set-square, etc., used in the drawing of geometrical forms, an ordinary 2-foot rule, and a 5-foot rod for the larger dimensions. This rod is generally made in two lengths connected with a spring joint, which permits it to be folded to about one-half its length. A plumb-line and a small tape will be found useful, while an accurate long tape is necessary.

4. Tapes.—The long tape may be made of linen or of ribbon steel, as shown in Fig. 1. The latter is less susceptible to alteration in length, but requires great care in use, as it must not be bent sharply, trodden on, nor exposed to a damp atmosphere unless oiled, for it will rust easily. The tape should be 50, 66, or 100 feet in length and marked in inches divided into $\frac{1}{4}$ inches, with, in the case of the linen tape, the feet marked in a distinctive colour throughout. All measurements must commence from the extreme outer edge of the ring, for the length of the ring is included in the first inch marked on the tape. The method generally adopted by one holding the free or ring end of the tape, when measuring, is to place the thumb in the ring and press it tightly against the face from which a measurement is desired. This ensures that the end of the tape will be in correct position, and also allows the

FIG. 1

tape to be pulled tight by the person reading the dimensions at the other end.

5. Chains.—Although the tape is generally used by an architect when measuring existing buildings, and is often used for measuring small sites, for large sites or estates the measurements are usually taken by means of a **chain.** One of the chains in common use, called *Gunter's chain*, is 66 feet long and is divided into 100 links of 7·92 inches each ; the *100-foot chain* is divided into 100 parts of 1 foot each. The latter chain is generally used by an architect when measuring sites or estates for building operations, as the dimensions taken by it, being in terms of feet and inches, will agree to a greater extent with those to be adopted for his plans than will dimensions taken by Gunter's chain.

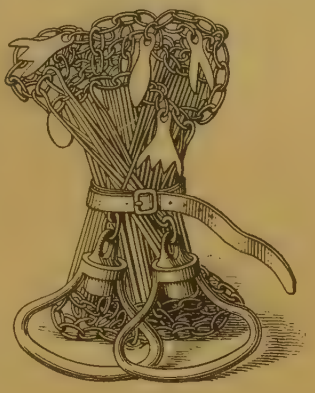


Fig. 2

6. A common form of 100-foot chain is shown in Fig. 2. It is made of steel or iron wire from $\frac{3}{16}$ to $\frac{1}{8}$ inch in diameter, with brazed links or rings joining the links. At each end of the chain is a brass handle with a swivel joint connecting it to the chain. In some chains one of the handles is provided with a screw and nut for adjusting the length of the chain to suit variations in temperature, but this adjustment is

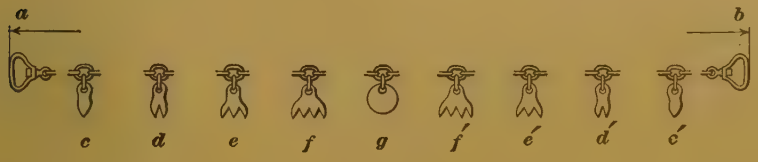


Fig. 3

liable to wear and become loose. At each 10 feet of the chain in length is attached a brass tag or marker, as shown in Fig. 3, to indicate the number of feet from the end. From *a* to *b* represents 100 feet. At *c*, *c′* are shown the 10-foot tags, so that if, when

measuring from a certain point, and commencing with the end *a*, the point *c* is reached, it is known that it is 10 feet from *a*; but if *c'* is reached, it is known that this point is 10 feet from *b* or 90 feet from *a*. At *d* and *d'* are shown the 20-foot marks; at *e* and *e'*, the 30-foot, and at *f* and *f'*, the 40-foot marks. The 50-foot mark *g*, or centre of the chain, is indicated by means of a circular tag. The *links* are usually each 1 foot long, but in some chains 6-inch links are used.

Fig. 4

7. **Arrows.**—**Arrows** are stout steel wire rods, measuring from 9 to 12 inches in length, and are used for marking and recording chain lengths. As shown in Fig. 4, they are pointed at one end while the other end is bent into a ring. When used in grassy or weedy ground, pieces of red or white cloth should be tied to the ring, so that the position of the arrow may be easily found. A set should consist of ten arrows, as this number greatly facilitates the reckoning of distances.

8. **Poles.**—**Poles,** sometimes called **ranging poles,** are used to mark points to which dimensions are to be taken, or for the purpose of defining direction of lines on the ground. These poles are usually 6, 8, or 10 feet long, and are made of well-seasoned wood about $1\frac{1}{2}$ inches in diameter, with a pointed iron shoe at the bottom, so that they may be easily forced into the ground. They are usually graduated in feet, and the foot spaces are painted alternately red and white or any other colour desired. A typical 6-foot pole is shown in Fig. 5; the distances *a b*, *b c*, etc., represent 1 foot. For ordinary surveys that will come within an architect's practice, it will be necessary to take about twelve poles. Small poles, called **pickets,** or **false pickets,** similar to the ranging pole, but about 3 feet long, are used to mark the positions of the points fixed by the ranging poles when these are needed for use on another part of the survey. A picket should of course be inserted in the hole formerly occupied by the pole.

Fig. 5

METHODS OF MEASURING

DIFFICULTIES AND OBSTRUCTIONS

9. Definition.—A **measured drawing** of an existing building is one that shows exactly, to scale, in plan, elevation, or section, the building or object to be represented. It takes no account of perspective, but simply shows the details and parts geometrically. In fact, it is a drawing similar to the one prepared by the architect for the builder to work from when the structure was erected. To make it, all the details of the building must be measured and these measurements drawn or *plotted* to scale, the scale selected depending on the size of the drawing required.

10. System of Triangulation.—When measuring and plotting the plans of buildings, the problems and difficulties which constantly arise can be settled by the application of the principles of **triangulation.** If the lengths of the two sides of a room are known, the angle at which the two sides meet can be accurately determined by measuring the diagonal across the room, thus

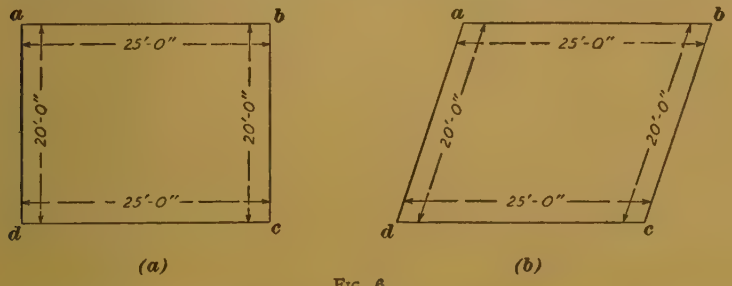


FIG. 6

dividing it into a series of triangles, or across from two points in two adjacent sides of a room. On entering a room of rectangular form, the plan of which is to be measured, it may appear to the beginner that only four dimensions, that is, the length of each wall, are necessary to make its plan complete, but to obtain an accurate plan, at least five dimensions must be taken. For instance, in Fig. 6 (*a*) is shown the plan of a room *a b c d* in which the lengths of the walls are, respectively, *a b*, 25 feet ;

b c, 20 feet ; *c d*, 25 feet ; and *d a*, 20 feet ; while in (*b*) is shown the plan of a room *a b c d* having walls *a b*, *b c*, *c d*, *d a*, of exactly the same dimensions, yet the plans of the two rooms are very unlike. Therefore, to obtain the correct plan of a room, unless it is known to be quite rectangular, at least five dimensions are necessary.

11. In Fig. 7 (*a*) is shown the method that should be adopted to obtain an accurate plan of the room shown in Fig. 6 (*a*). The diagonal dimensions *a c*, *d b* which divide the room into a series of triangles must be taken in addition to the sides of the room. These diagonals *a c*, *d b* are each 32 feet, which dimension is as correct as it is possible to obtain it with the average linen tape, though, if the angle *a d c* is a right-angled triangle,

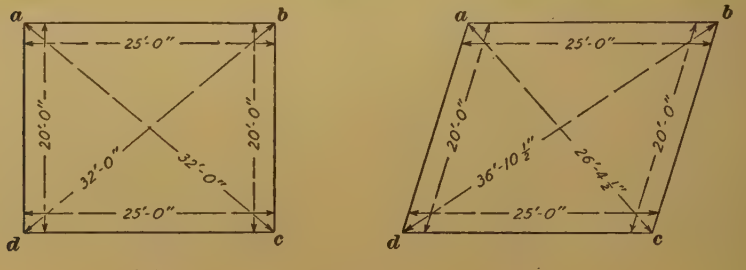


FIG. 7

with the sides *a d* and *d c* forming the right angle, the side *a c*, or the hypotenuse, will be slightly more than 32 feet. In Fig. 7 (*b*) is shown the correct method to be adopted in measuring the room shown in Fig. 6 (*b*). Here, also, the diagonal dimensions *a c*, *b d* are taken, one being necessary in order to plot the figure and the other is advisable as a check dimension.

12. To plot a room when the diagonals have been taken, draw the line *a b* correctly to scale and of the required length, in this case 25 feet. Then, with *b* as a centre and a radius the length of the adjoining side, or 20 feet, describe an arc of a circle in about the position where it is thought the farther end *c* of this side will fall. With *a* as a centre and a radius equal to the diagonal *a c*, or 26 feet $4\frac{1}{2}$ inches, describe another arc cutting the previous one in the point *c*. Join the points *b*, *c*, and

the angle *a b c* will be the correct angle at which the sides *a b* and *b c* join each other. With *a* as a centre, describe an arc having a radius equal to the length of the adjoining side, or 20 feet, about the position where the point *d* may be expected to come ; and from *b* as a centre with a radius equal to the diagonal *b d*, or 36 feet $10\frac{1}{2}$ inches, describe an arc cutting the previous one at the point *d*. Join *a d* and *d c*, and if the working of the plotting has been done accurately, the dimension *d c* will scale exactly 25 feet. If this does not scale correctly, the whole of the working out must be done again. Great care must be taken in plotting such dimensions as this, as incorrectness to the extent of the thickness of a line will often put out the whole of the plotting.

13. Even if one of the side walls *a f e d* is not in a straight line, as shown in Fig. 8, the same system may be used. The

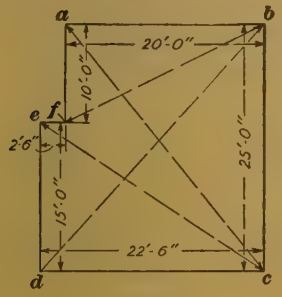


Fig. 8

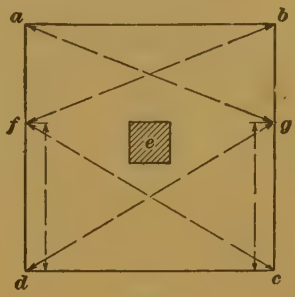


Fig. 9

length of all the walls *a b*, *b c*, *c d*, *d e*, *e f*, and *f a* should first be measured, then all the diagonal dimensions *a c*, *b f*, *b d*, *c e* carefully taken, by which means it will be found that the area of the room has been divided into a series of triangles, each of which can be plotted as just described. To plot the room shown in Fig. 8, the line *a b* equal to 20 feet should be drawn first, then, with *b* as a centre and a radius of 25 feet, an arc should be drawn about the position where *c* is expected to be. With *a* as a centre and a radius equal to the diagonal *a c*, this arc should be cut at *c*. When the points *b*, *c* are joined, these two sides of the room will be drawn in correct relation to each other. With *a* as a centre and a radius of 10 feet an arc should be drawn about the position where *f* is likely to occur ; and

with *b* as a centre and a radius equal to the diagonal *b f* this arc should be cut at the point *f*; the points *a*, *f* should then be joined. In a similar manner the point *d* is found by intersecting arcs drawn with *b* and *c* as centres; and *e* is found by intersecting arcs drawn with *c* and *d* as centres, the only remaining work to be done after joining up these points is to join *e f*, which, if the plotting has been correctly done, should measure exactly 2 feet 6 inches as shown.

14. Obstructions.—Should it be impossible to take diagonal dimensions across a room, owing to the existence of some obstruction, such as a column or piece of furniture, such a scheme as is shown in Fig. 9 must be resorted to. Here the diagonals *a c* and *b d*, Fig. 8, cannot be taken owing to the obstruction *e*, so artificial points must be adopted as a basis for the system of triangulation. On the walls *a d* and *b c*, any two points *f* and *g* distant as far as possible from the corners *d* and *c* should be taken. Dimensions should be taken from *d* to *c*, from *d* to *f*, and *f* to *c*, which will give sufficient information for the triangle *f d c* to be plotted. Next take the dimensions *g c* and *g d* which will permit the triangle *g d c* to be plotted, as the line *d c* is common to both triangles. Measure the walls *d a* and *c b*, and plot them on the drawing, producing the lines *d f* to *a*, and *c g* to *b*. Join *a b*, which should scale on the drawing exactly what it measures on the building; but as an additional check, the diagonal dimensions *f b* and *g a* should also be taken, thus ensuring accurate work.

15. Thickness of Walls.—It is necessary when measuring for the plans of an existing house to connect the various rooms, which can be measured accurately by means of the system of triangulation. For this purpose, in ordinary buildings the walls and partitions are taken to have parallel sides, but their thickness must be measured, or *taken*. Where doors or windows occur in a wall or partition, the thickness of a wall or partition dividing two rooms, or a passage and a room, can be readily obtained by measuring through the door opening; but about $\frac{3}{4}$ inch must be deducted for each plastered face to ascertain the actual thickness of the construction in the partition or wall.

16. When two rooms are divided by a wall or partition *a*, Fig. 10, in which there is no opening, the exact plan of these two rooms must be obtained by taking the lengths of the walls and the diagonal dimensions. The thickness of the wall *c* in which the doors occur is easily measured, and can be plotted accordingly. The dimensions *d*, from the door opening to the face of the wall in room *1*, and *e*, from the door opening to the face of the wall in room *2*, should then be taken Then the distance *f* between the openings outside the rooms should be measured, taking the same positions on the openings as the dimensions *d* and *e* were taken. The sum of the first two dimensions *d*, *e* must then be deducted from this last.

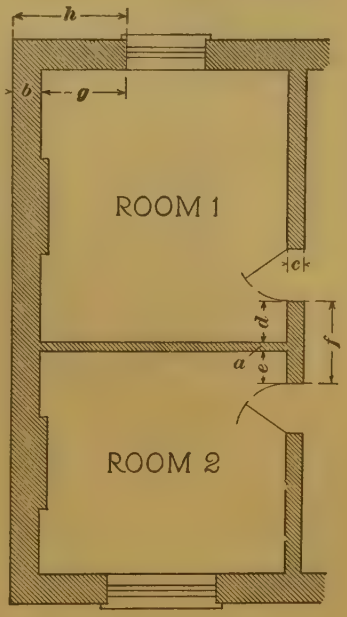


FIG. 10

To obtain the thickness of an outside wall *b* in which there are no openings, take the dimension *h* from the reveal of the window opening to the outer edge of the wall; then on the inside measure *g* from the same position on the window to the inner face of the wall. Deducting the inside measurement from the outside gives the thickness of the wall, one face of which is probably plastered.

17. Door and Window Details.—When measuring the plans of an existing building to which it is desired to make alterations or additions, it is generally sufficiently accurate to obtain the plan of a doorway by taking its clear opening only. Windows are usually taken by measuring the outside dimension between the reveals and the inside dimension between the jambs or linings. More detail cannot be shown on a drawing plotted to the scale of 8 feet to 1 inch, the usual scale adopted.

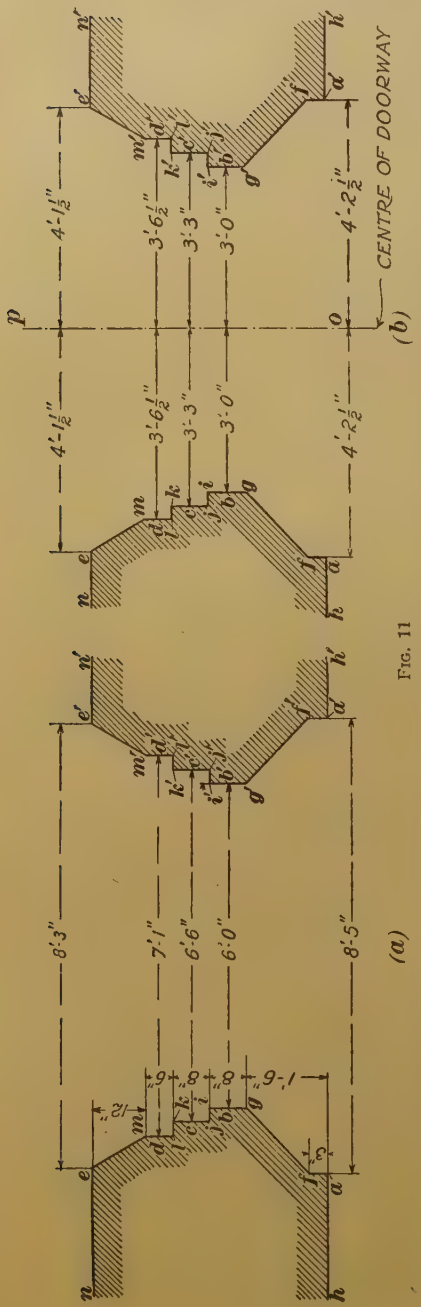


Fig. 11

18. If, however, more detail is required for a particular opening or portion of the building, it can be obtained by measuring as shown in Fig. 11, where (*a*) is a plan through a door opening, with the door itself omitted. It is necessary that care should be taken to obtain **overall dimensions**, that is, the dimensions should be taken right across the opening, when it is similar on both sides of a centre line, as in (*a*). To do this, a rough sketch of the plan on which the dimensions can be placed should be made. Then the overall dimension giving the width of the opening on the outside from *a* to *a'*, in this case 8 feet 5 inches, should be measured and put down on the rough sketch. Arrowheads should be used to clearly define to where the dimension was taken. The next dimensions to be taken and noted are *b b'* equal to 6 feet, *c c'* equal to 6 feet 6 inches, *d d'* equal to 7 feet 1 inch, and *e e'* equal to 8 feet 3 inches. The distances *a f*, equal to 3 inches, and *a g*, equal to 1 foot 6 inches, should then be measured. To obtain this

latter dimension, a straightedge should be laid along the face *h a* of the front wall projecting out toward the centre of the door opening and from this the distance carefully measured back to the point *g*. From *g* measure to *i* 8 inches, from *j* to *k* 8 inches, and from *l* to *m* 6 inches. Then measure from *m* to a straightedge laid along the face of the wall *n e* 12 inches. In a similar manner the dimensions on the other side of the doorway may be taken, but they will probably be found to be similar.

19. Plotting the Dimensions.—The method to be used in plotting the dimensions taken in Fig. 11 (*a*) is shown in view (*b*). Wherever an opening is similar on both sides of a centre line, the dimensions should be plotted from a centre line. The first thing to do is to draw a faint line through *h h'*, in (*b*), on which should be plotted, to whatever scale it has been decided to work, the dimension *a a'* in (*a*) equal to 8 feet 5 inches. Bisect *a a'* in (*b*) at the point *o*; from *o* set up at right angles to *a a'* the line *o p*, which will be the centre line of the doorway opening. Now, from *a* in (*b*) set up *a f* equal to *a f* in (*a*), or 3 inches. On each side of the centre line *o p* set off 3 feet and draw through the points so found lines parallel to *o p*; these lines will give the faces equivalent to *b b'* in (*a*). From *a a'* in (*b*) set up a dimension of 1 foot 6 inches at right angles to *a a'*, and draw through the point so found a line parallel to *a a'*, which will cut the lines on which the faces *b b'* are situated at *g* and *g'*. Join *g f* and *g' f'*, and the splay so found will be equivalent to the splays *g f* and *g' f'* in (*a*). From *g* and *g'* set off the dimension *g i* and *g' i'*, equal to 8 inches at right angles to *a a'*, and through *i* and *i'* draw the lines *i j* and *i' j'* indefinitely, but parallel with *a a'*. On each side of the line *o p* set off the dimension 3 feet 3 inches, which is equal to one-half the dimension *c c'* in (*a*). Through the points so found draw the lines *j k* and *j' k'* indefinitely, but parallel with *o p*, cutting the lines *i j* and *i' j'* at *j* and *j'*, thus giving definitely the points *j* and *j'*. From *j* and *j'* measure along the lines *j k* and *j' k'* the distance 8 inches as shown at *j k* in (*a*), and through *k* and *k'* draw the lines *k l* and *k' l'* parallel with *a a'*. Measure off the distance 3 feet $6\frac{1}{2}$ inches on each side of *o p*, and through the points so found

draw lines indefinitely parallel with *o p*, cutting *k l* at *l* and *k' l'* at *l'* and fixing definitely the points *l* and *l'*. From these points draw *l m* and *l' m'* equal to *l m* in (*a*), or 6 inches, and from *m* and *m'* set off a dimension of 12 inches at right angles to *a a'* as shown in (*a*). Through the point so found draw a line *n n'* parallel with *a a'*. On each side of *o p* set off the dimensions 4 feet $1\frac{1}{2}$ inches and through the points so found draw lines parallel with *o p*, cutting the line *n n'* at *e* and *e'*, join *e m*, and *e' m'*.

MEASURING PROJECTING FEATURES

20. Square Bay.—The plan of a square-bay window, the measurements of which have to be taken from actual work, is shown in Fig. 12. A pencil sketch should be made as nearly

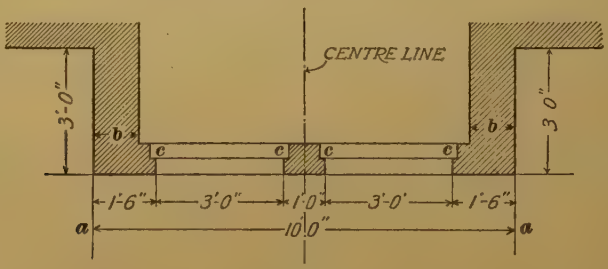


FIG. 12

in correct proportion as possible, so that the measurements may be placed on it as they are taken. The overall, or check dimension, is shown at *a a*. If it is desired to draw accurately the thickness of the wall *b* and the detail through the window jambs *c*, the procedure will be similar to that already described.

21. Bay With Splay Sides.—A variation of the square bay, in that two of its corners are cut off and formed into splay sides *b c*, *d e*, is shown in Fig. 13. To measure this bay, first make the pencil sketch and put on it the dimensions *a b*, *b c*, *c d*, *d e*, *e f* of the sides of the bay. To obtain the angle of the splay, produce the line *d c* to *g* by means of a board or straightedge; also produce the line *a b* to *g*, care being taken that *a g* is at right angles to *d g*, which can be checked by means of a set-square. Measure *b g* and *c g*; after these are carefully placed

on the pencil sketch, the angle of the splay can be plotted quite easily The other side of the bay should be treated in a similar

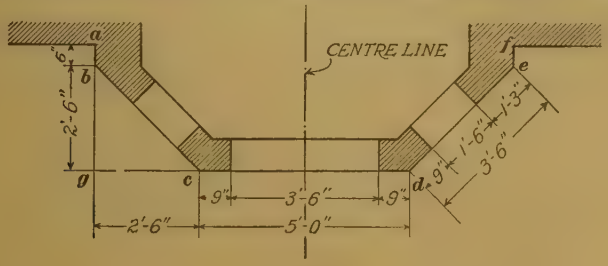


Fig. 13

manner, for both sides may not be similar. The window openings in the walls and the thickness of the wall will be obtained in a manner similar to that before described.

22. Segmental Bay.—In Fig. 14 is shown a more difficult problem to measure. After the pencil sketch has been drawn, a base line *d e* must be laid on the ground, either in chalk or by means of a long lath or piece of timber, tangential to the curve of the bay at *a* and parallel with the main wall line *g f*. To

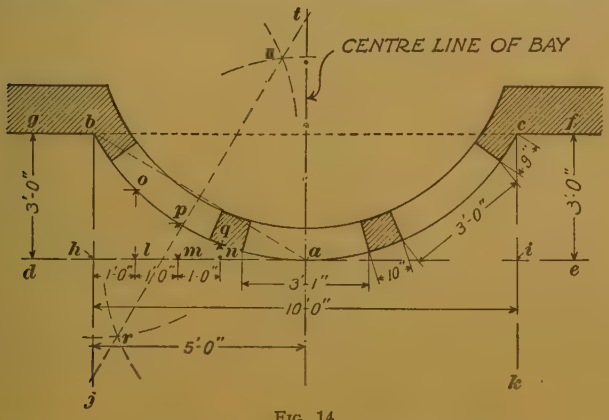


Fig. 14

ensure its being parallel to the wall line, it should be set approximately so and the distances *e f* and *d g* measured; the rod or line should then be moved backwards or forwards until the two dimensions *e f* and *d g* are equal, in this case 3 feet. Then, from *b* set up a line *b j* at right angles to wall of the building *g f*

and cutting the base line *d e* at *h*. On the other side of the bay, set up a line *c k* at right angles to wall of the building *g f*, cutting the base line *d e* at *i*. Then measure *h i* along the base line *d e*, when it will be found to be 10 feet or the correct width of the bay at *b c*. The correct width of the bay at the wall face, and the greatest projection of the bay to the face *a* from the wall line *g f*, are now known.

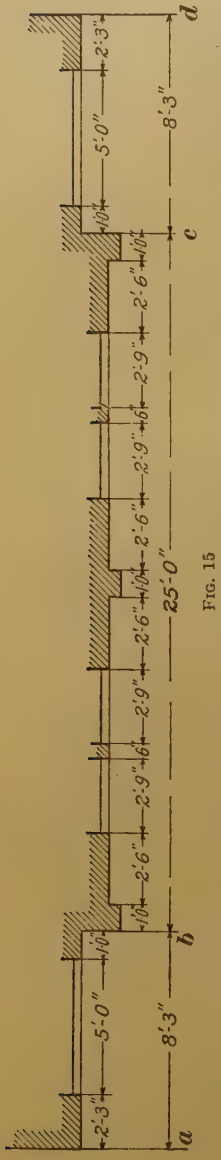


Fig. 15

23. The shape of the curve may be determined by means of *offsets*, or a series of dimensions taken to the curved face of the bay at right angles to the base line *d e*. To do this, from *h* measure off spaces along the base line *d e* at any convenient distance, as 1 foot, apart. Then at each of the points *l*, *m*, *n* so found set up lines at right angles to the base line *d e* until they touch the face of the bay at *o*, *p*, and *q*. Then carefully measure these lines *l o*, *m p*, *n q*; when plotting these dimensions a line drawn through the points *b*, *o*, *p*, *q*, *a* will give the correct curve for one-half of the bay. The other side should be measured in a similar manner. If the curve is regular, it may be drawn in with the pencil bows. To find the correct centre for turning, join *b* and *a*. Then, with *a* and *b* as centres, describe arcs of similar radius that intersect at *r* and *s*, join *r* and *s*, and produce the line until it cuts the centre line of the bay at *t*, which will be the centre of the curve of the bay *b o p q a*.

24. Check Dimensions.—In order to check the detail measurements, overall dimensions should be taken in all places possible. If these dimensions and the sum of the detail measurements agree, the detail measurements may be taken to be

correct. In Fig. 15 is shown the plan of a front wall of a house in which a series of running dimensions have been taken to indicate the positions of the various window openings, projections, recesses, etc. The smaller dimensions have been obtained with the 5-foot rod or the 2-foot rule, therefore though every care has been taken to get the dimensions accurate, each may be $\frac{1}{8}$ or $\frac{1}{4}$ inch wrong. These must therefore be checked by taking overall dimensions *a b*, *b c*, *c d*, which it is found agree with the smaller dimensions when added up, thus proving that the shorter dimensions are correct.

SURVEY OF A HOUSE

TAKING THE DIMENSIONS

25. Preliminary Sketch.—When commencing a survey, the building should be carefully examined, so that an idea of its plan may be obtained and a scheme for measuring determined. A sketch plan should then be made in a book or on a sheet of paper on a drawing-board, on which the dimensions can be placed as they are taken. These sketch plans often get dirty, but so long as the outline of the plan is discernible and the figures are clear enough to enable a finished drawing to be plotted from them, their end is attained.

26. Taking Measurements.—The sketch plan having been completed, the dimensions can be taken and put down on it, as shown in Fig. 16. Frequently it will be necessary to make a more detailed sketch of certain parts, for instance, of the offices, stairs, and other parts of the building, in order to find clear room for all the required dimension figures. A definite scheme or order for taking the dimensions should be arranged, and no one room should be left until all the dimensions necessary, so far as can be seen, have been taken. The front or back room in the house should be commenced first and then the next room to it, and so on until the ground floor has been completed, when, if there is a basement or cellar, this should be sketched and measured, after which the upper floors and roof can be commenced. The sketch in Fig. 16 contains all the dimensions

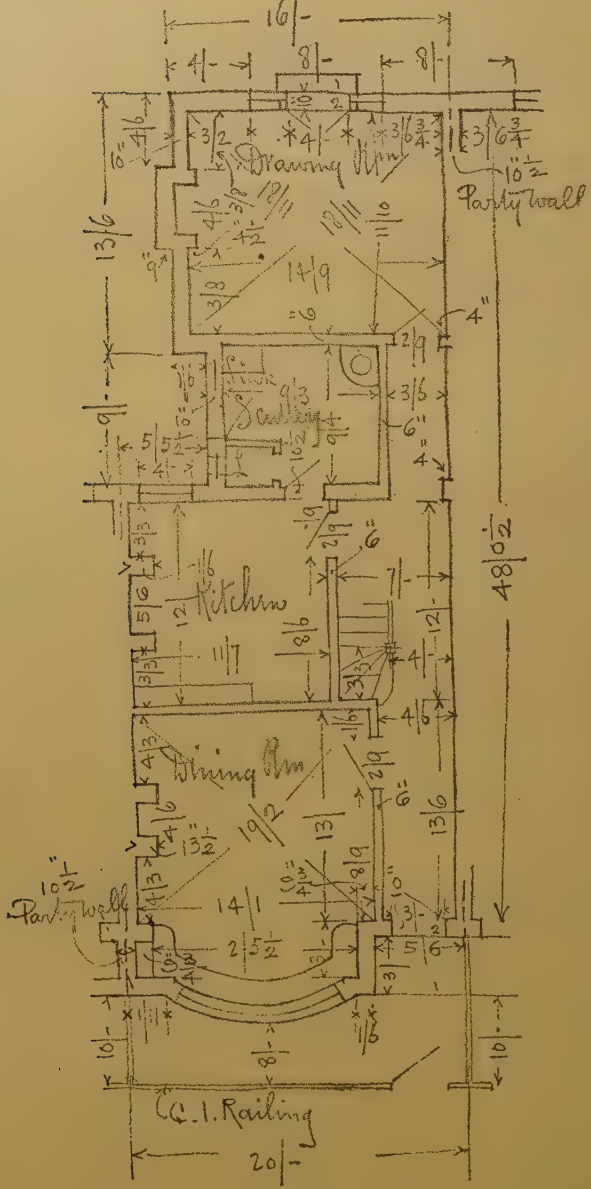

Drawing Rm
Party wall
Scullery
Kitchen
Dining Rm
Party wall
C.I. Railing

FIG. 16

necessary, with the exception of several dimensions in the scullery and round the dining-room bay window. A sketch of the scullery and bay window should be made to a larger scale, so that the great number of dimensions necessary may be clearly shown. In Fig. 17 is shown an enlarged sketch of the scullery as it would be necessary to draw it if it were being measured from an actual example.

27. As the plan shown in Fig. 16 is that of a terrace house, there is a party wall on each side. The only way to obtain the thickness of these walls is to measure to the face of the wall on each side from a window opening, then measure on the outside face between the two window openings, when the difference between the outside measurement and the sum of the inside measurements will be the thickness of the party wall. In such a case as that shown in Fig. 16, permission would have to be obtained from the occupiers of the house on each side to take certain dimensions from their window to the face on their side of the party wall. As a rule, no difficulty will be encountered in obtaining this permission.

PLOTTING THE DIMENSIONS

28. The plotting of the dimensions for a complete set of drawings for a house of the size of that shown in Fig. 16 would take a long time, but the principles of plotting are the same as for a small portion of the house. Therefore, only the enlarged scullery plan will be plotted, all the dimensions being taken from the sketch plan shown in Fig. 17. Any scale may be used, but scales of $\frac{1}{8}$ and $\frac{1}{4}$ inch to the foot are often adopted.

The first line *a b*, Fig. 18, to be set out, which also acts as a base line, is 9 feet 3 inches long, as this is the width of the scullery. With *b* as a centre and a radius of 9 feet 4 inches, an arc is now drawn in the probable position of the point *c*; to definitely fix this point *c*, an arc is drawn about *a* as a centre and with a radius of 13 feet 2 inches. The line *b c* may now be drawn. As the larder makes it impossible to reach the other corner of the room, the distances *a d*, *c e* to the larder partitions from the points *a*

and *c* are found. To determine the position of the point *d*,

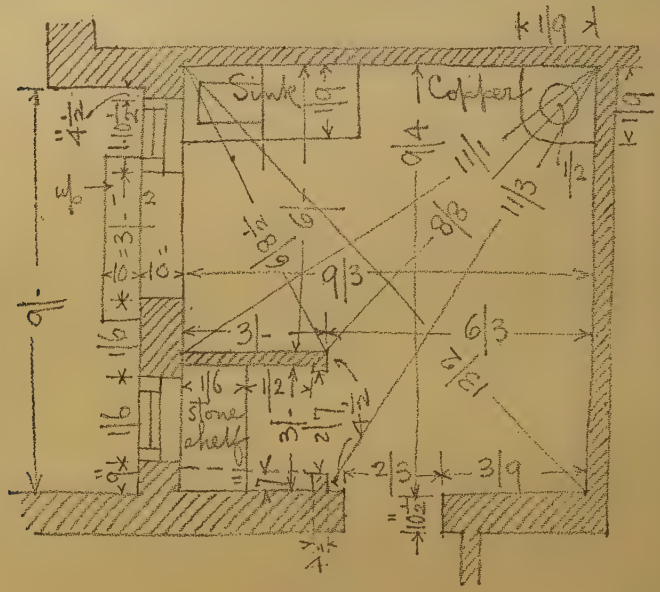


FIG. 17

arcs having radii of 6 feet and 11 feet 1 inch, respectively, are struck from *a* and *b* as centres; the line *a d* should be continued indefinitely. By striking from *b* and *c* arcs that have radii of 11 feet 3 inches and 6 feet 3 inches, respectively, the point *e* is found; the line *c e* should be continued until it intersects the line *a d* continued. The other corner *f* of the larder is found by striking from *d* and *e* arcs having radii of 3 feet and 3 feet 4 inches, respectively.

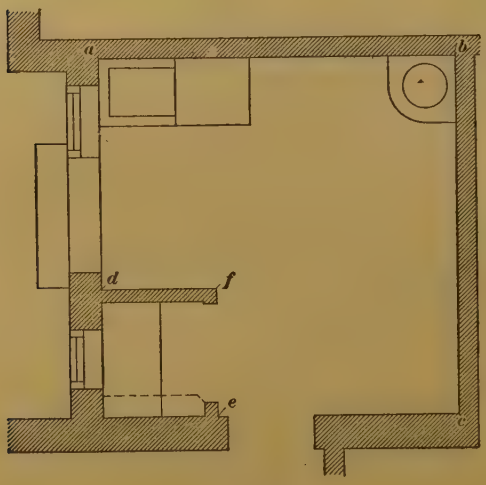


FIG. 18

This point should be checked by measuring 6 feet $8\frac{1}{2}$ inches from the point *a* and 8 feet 8 inches from the point *b*. If these check dimensions do not scale correctly, the plotting should be carefully gone over again.

29. After the outline of the internal face of the walls enclosing the scullery has been plotted, the detail may be put in from the dimensions in Fig. 17. The thickness of the walls should be plotted first of all. As the wall of which *a b*, Fig. 18, is one face is 6 inches thick, according to the dimensions in Fig. 16, a line must be drawn parallel to *a b* and 6 inches away from it, as shown. In a similar manner, a line is drawn parallel with *b c*. The dimensions show that the wall of which *c e* is one face is $10\frac{1}{2}$ inches thick, therefore a line must be drawn parallel with *c e* and $10\frac{1}{2}$ inches from it; this line must be continued indefinitely to form the boundary wall of the larder, as shown in the sketch. The thickness of the partitions enclosing the larder may now be inserted and the door opening may be shown, the jambs of which are placed $4\frac{1}{2}$ inches from each end of the shorter side.

30. The outside wall is shown to be 10 inches thick; its thickness should now be drawn. The doors, windows, and steps can be drawn in from the dimensions given in Fig. 17. It is usual in a survey of this kind simply to show the door openings by single lines, as shown in Fig. 18. If the sink and draining board, copper, and shelves in the larder, together with the door opening leading from the scullery to the kitchen, are now put in, the plotting of the scullery plan will be complete. In a similar manner, the whole of the plan shown in Fig. 16 would be plotted if a complete set of dimensions and sketches had been taken.

31. It may be found when plotting the dimensions that a tie-dimension does not check to $\frac{1}{2}$ inch or 1 inch with the detail dimensions which it covers; this can well be allowed to pass, as the tape is always somewhat uncertain and is very liable to stretch slightly under varying conditions. When taking diagonal dimensions, it will also be found, if they are checked by arithmetical methods, they will not quite agree. Taking the two dimensions along *a b* and *b c*, Fig. 18, as 9 feet 3 inches and

9 feet 4 inches, the square root of $(\overline{ab}^2 + \overline{bc}^2)$ should give the correct length of $a\,c$; but the square root of [(9 feet 3 inches)^2 + (9 feet 4 inches)^2] is 13 feet 1·7 inches when worked out arithmetically, although the dimension taken on the building is 13 feet 2 inches.

32. When the plans of a building have been completely measured sketches should be made of the elevations and sections, but only the heights should be measured for these as the position of the various window and door openings can be obtained from the plans. A ladder is often necessary to complete the measurements of the elevations, but many dimensions can be taken by dropping one end of the tape out of an upper window and measuring from the sill line to some definite point below. The height to the gutter line of the roof can generally be obtained from the top-floor window. Care should be taken to measure the height from floor to floor, the heights of the various windows, doors, etc., that occur, and the level of the ground round the house.

33. Surveying a Detached House.—If a house is to be measured that is standing in its own grounds, the boundaries of the site can often be measured by the tape, taking the house itself first and measuring from its several corners to points on the boundary of the site by means of the system of triangulation. It is always safer to take too many dimensions rather than too few, and, to determine the position of points on the boundary of a site with a house built somewhere within it, a great number of dimensions may have to be taken to form the system of triangulation. This plan is perfectly satisfactory when the boundaries are straight and the lines of them near the house can be produced in a straight line to obtain the back boundary, but where the boundaries are irregular it is better to measure the site by means of a chain. When the site is measured by chaining one of the chain lines should be taken as a base and the position of the house or other building determined from this by a system of triangulation. The base line is then a longer line than it would be if a side of the house were taken, and there will be less likelihood of error.

CHAIN WORK

TAKING THE DIMENSIONS

34. Requisites for Chain Work.—When the distances to be measured exceed the length of a tape, they can be better determined by the use of a chain. Also, in wet or muddy weather, not only will a tape used out of doors get very dirty, but it will be almost impossible to keep the sketch clean enough to be clear; besides, a tape cannot be drawn tight when exposed to much wind. A chain should always be examined before it is taken to the site. To do this, remove the enclosing strap of leather, grasp both handles in the left hand, holding the chain in the right, then, having shaken free the first few links of either end, throw the chain forwards, while stepping back a few paces. The chain should then lie extended on the ground, but folded in half. Dropping one handle, walk forwards with the other until the chain is fully extended in a straight line. It should then be examined, and all kinks removed and all bent links straightened. The length of the chain can now be checked by a steel tape, but preferably by a measuring rod or rods. If only one rod is used, it will be necessary to make a series of marks on the pavement or level ground at the end of each measurement, and great care must be taken, both in the marking and in the measuring from them. There are, however, testing marks in most of the important towns throughout the United Kingdom, besides the official standards in Trafalgar Square and the Guildhall, in London. The chain should now be refolded ready for conveyance to the site. Besides the poles and bundle of ten arrows, a dozen or more pointed stakes about $1\frac{1}{2}$ inches square and about 3 feet long should be taken for marking points on the ground. These should be clean from the saw, or whitened, in order that they may be readily discerned at a distance. A stiffly bound notebook of a size convenient for the pocket will also be necessary.

35. Folding the Chain.—To fold the chain from the centre, take the two middle links together in the left hand, grasp the

third pair of links from the middle with the right hand, and fold the second and the third pair of links across the middle links and nearly parallel to them; then grasp the fifth pair and fold the fourth and the fifth pair across and nearly parallel to those already folded, and so on until the chain is entirely folded. It should then be secured by a cord or strap round the centres of the links.

36. Common Sources of Error in Chaining Lines.—The length of a chain or tape is altered by changes in temperature, and by wear and distortion. The variations due to temperature are very small, and need not be considered except in very accurate work. The alterations due to wear and distortion are sometimes considerable, and should be allowed for. An error of 2 or 3 inches in the length of a chain is not uncommon, especially when the chain has been roughly used. This shows the necessity of handling the chain very carefully. If the chain is caught, as in a stump or stone, it should not be disengaged by pulling from the end, as this may stretch the rings and bend the links. Although, in measuring, the chain should be held taut, it should not be pulled with so much force as to cause stretching of the rings. A uniform pull should always be given to the chain, so that each length measured is as nearly the same as possible. Some of the chief sources of error in surveying are: (*a*) lack of alinement, or not measuring in a straight line; (*b*) not holding the chain or tape level; (*c*) failure to tally, or add up the arrows and lengths correctly; (*d*) errors in reading the tape or chain; (*e*) not giving a uniform pull on the tape or chain.

37. Preliminary Survey.—Before proceeding to make a chain survey of any plot of ground, it is necessary to make a sketch plan on which the system of triangulation to be adopted may be indicated. For this purpose a large-scale ordnance map is of great assistance, for from this the plot in question may be plotted with accurate proportions and the compass point inserted. Next, the site should be explored in order that any obstacles, such as ponds, trees, and buildings, may be approximately sketched in.

38. Survey Distances Are Horizontal.—All surveying distances, except those used in levelling, are understood to be horizontal; they are determined either by measuring horizontally or by reducing inclined distances to horizontal distances. Thus, in Fig. 19, by the distance from A to B is meant the distance $A\,B'$, measured along the horizontal line $A\,X$, from A to B', the latter point being the foot of a perpendicular (a vertical line in this case) from B to $A\,X$. The line $A\,B'$, or any other horizontal line, as $A''\,B''$, between two verticals through A and B, is called the **horizontal projection** of $A\,B$.

The distance $A\,B'$ is obtained by a series of horizontal measurements $A'\,C$, $C'\,D$, and $D'\,B$, the points A', C', and D' being vertically above A, C, and D, respectively. The sum of these horizontal measurements $A'\,C$, $C'\,D$, and $D'\,B$ is equal to $A\,B'$,

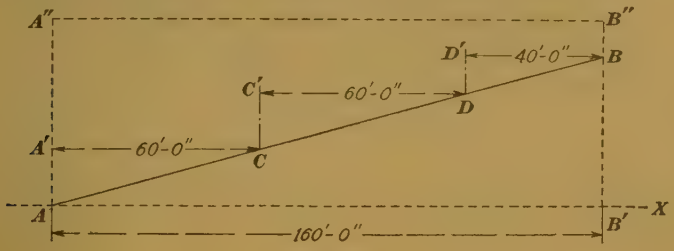


FIG. 19

which is referred to as the distance between A and B. If the distance $B\,B'$, which is the difference in elevation between A and B, is known, the inclined distance $A\,B$ may be measured, and the distance $A\,B'$ calculated from the relation $A\,B' = \sqrt{\overline{A\,B}^2 - \overline{B\,B'}^2}$.

39. The lines plotted on a survey drawing are the horizontal projections of the real lines in the field, and the drawing itself represents the horizontal projection of the tract surveyed. It should be borne in mind that, when a line is referred to, its horizontal projection is meant; that, by the distance between two points is meant the horizontal distance between two verticals through those points; and that by the angle between two lines is meant the angle between the horizontal projections of the lines.

40. Base Line.—Having sketched out the preliminary survey, the system of triangulation to be adopted must be put on it; and a main, or *base*, line on which the triangles are to be formed must first be determined. In Fig. 20 is shown a sketch, or preliminary survey, of an open field as it would be drawn in the first instance. The base line adopted is the diagonal *1–6*. At the ends *1*, *6* of this line a pole should be placed, from and to which measurements may be taken. If a pole is placed at *5*, the corner where the boundary of the field sharply changes direction, and another at *2*, a triangle *1–2–5* will be determined. By inserting a pole at the point *4*, a triangle *1–6–4* will be determined. The only point now not fixed is the corner of the field

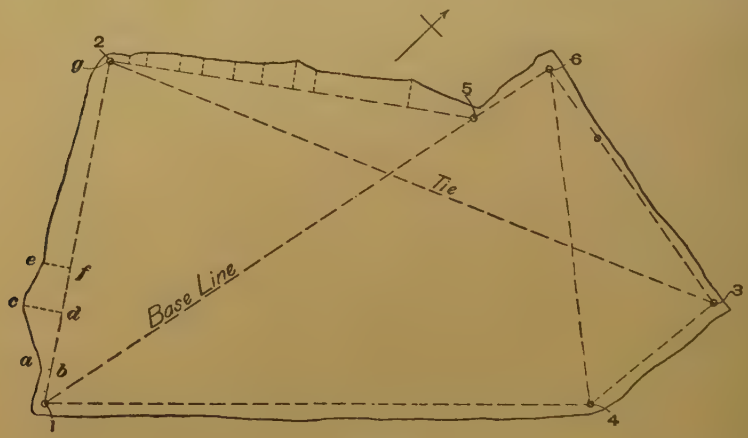


FIG. 20

at *3*. If a pole is placed here, the point *3* may be fixed by measuring the sides *6–3* and *4–3* of the triangle *6–3–4*, and the tie-line *2–3* should be measured as a check or tie-line to the whole of the three triangles. The chain lines are often numbered so as to readily describe them in the dimension book. When this is done, they should be numbered with figures enclosed in circles, thus (7), to distinguish them from the stations which are simply numbered in the ordinary way.

41. Field Work.—The positions of the poles *1*, *2*, *3*, *4*, *5*, *6* having now been determined, if the distances between these

points are measured accurately on the field, their positions on a drawing to scale may be readily fixed by plotting the triangles of which they form the apexes. Commencing with pole *1*, the six poles should be securely fixed in the ground about 1 foot 6 inches from the two boundaries of the field, care being taken that they are vertical. As pole *5* is on the line *1–5* produced, care must be taken on the field that the poles *1*, *5*, *6* are in one line.

42. Ranging of Poles.—To fix the position of pole *5*, an assistant should hold the pole vertically, approximately in position, and about 1 foot 6 inches away from the boundary of the field. The surveyor, standing behind pole *1*, should then sight through to pole *6*, and, by waving his hand to the right or left, should direct the assistant to move the pole as necessary in order that the three poles *1*, *5*, *6* may be in one straight line. When he is satisfied that the position of pole *5* is correct, he should drop his arm, by which action the assistant will know that the correct spot for the pole has been determined and inserts the pole vertically in the ground at that point.

43. Taking Measurements.—It is assumed that the surface of the field shown in Fig. 20 is practically level, so that the method of taking the dimensions consists in measuring the several distances from pole to pole, as shown by the dotted lines. This will give the correct positions of all the poles forming the apexes of the various triangles, but will not give the outline boundary of the field.

44. Offsets.—The outline of the boundary of the field is determined by means of **offsets.** These are short dimensions taken at right angles to a chain line to determine the distance of the boundary from the chain line at a certain point along its length. Fig. 20 shows that the chain lines are straight and follow, as nearly as possible, the boundaries of the field; but to determine the exact contour of the boundary, offsets *a b*, *c d*, *e f* must be taken along the length of the chain so as to obtain the exact outline of the boundary. The more irregular the boundary of the field the greater will be the number of offsets necessary to fix its outline. Offsets are often measured by means of a special offset staff, which is very similar to an ordinary

station, or ranging, pole. It is ten links long and often has a hook formed at one end to aid in drawing a chain through a hedge if necessary. For an architect's surveys, the poles are generally used to take offsets with, and for this reason they are divided into 1-foot lengths by coloured bands.

45. Chaining a Line.—Two men are necessary for all chaining operations, and a third one to carry the poles, notebooks, and other instruments is always helpful, as the surveyor and his assistant are then left free to attend to the actual chaining and taking and booking of dimensions. The two men in charge of the chain, and who take the dimensions, are in surveys of ordinary size for architectural purposes the surveyor and his assistant, and are usually designated the **leader** and **follower** according to the position in reference to the direction in which the dimension is being taken. The chain should be thrown out by the follower, if possible in a direction opposite to that in which chaining is to be done, so that he may observe and straighten out any kinks as the chain is drawn past him by the leader, who drags the chain by one of the handles in the direction of the line, while the follower, holding the other handle, remains at the beginning of the line.

46. When the leader starts, he takes with him the ten arrows. To chain the line between poles or stations 1 and 2 in Fig. 20, the follower should stand by the extreme boundary of the field and the leader should walk toward station 2 dragging the chain with him. Station is commonly abbreviated Sta. When the chain is drawn tight, the follower should place the end of his handle at the extreme edge of the boundary behind Sta. 1 and sight along the chain to see that it runs directly along the line set out by the Stas. 1, 2. He should then direct the leader, by waving his hand to the right or left, as to which way it is necessary to move his end of the chain to ensure its lying along this line. Care must be taken that the chain is stretched tight all the time. When the exact position is determined, the follower should drop his hand, which will signify to the leader that his end of the chain is in the correct position, so that he may insert an arrow in that position.

47. Inserting Arrows.—The method to be adopted by the leader for holding his end of the chain and inserting the arrow is very important. The leader should not stand directly in front of the length of chain, as then the follower will not be able to sight through on the length of chain to the next station to see that the chain is running in a straight line between the stations. He should stand sidewise away from the chain, with the handle and an arrow in his hand at the same time. He should face the follower so that he may see his signals and move his end of the chain accordingly. Then, when the follower gives the signal that the correct position for the leader's end of the chain has been found, the leader should insert the arrow at once and drop his end of the chain. The correct method of holding the chain and arrow is shown in Fig. 21.

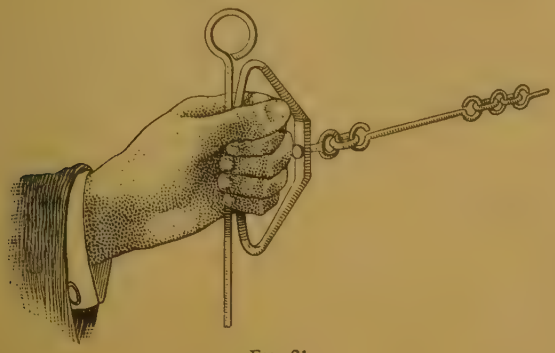


FIG. 21

48. The follower, after the leader has inserted his arrow, should drop his end of the chain and proceed to read and book the dimensions. He should commence with a note that the chain began from the back fence, and his first dimension, probably about 1 foot 6 inches, or 2 feet, will signify the position of Sta. 1, at which position he will take his first offset, reading it from the centre of the pole to the extreme boundary of the field. He should then proceed to take offsets along the length of the chain. These should be taken as often as necessary to obtain the correct outline of the boundary, but for boundaries that do not vary much in outline it is sufficient to take offsets about every 25 feet. Any sharp break or turn in the boundary should

be noted by booking its distance from the beginning of the chain and its offset distance from the chain.

49. When the follower comes to the first arrow, the leader should drag his end of the chain along toward the Sta. 2, Fig. 20, until the rear end is at the arrow first inserted. The follower should then hold his end of the chain against the arrow and direct the leader where to place the next arrow, as before described. When the arrow is inserted the chain is dropped as before and the offsets are taken along its length. The follower, before commencing to take the offsets, picks up the first arrow and carries it with him. This process is repeated all along the line, when it is found that Sta. 2 is 350 feet along the line from the boundary at which chaining on the line *1*, *2* was commenced, and the boundary past Sta. 2 is 6 feet more.

50. Method of Reckoning.—When the point to which measurement is being made is reached, in this case the boundary next Sta. 2, the leader drags the chain on until the rear end is at the last arrow. He then returns and notes the number of links from the last arrow to the boundary. This added to the number of chains will give the total distance chained. When taking the line through Stas. 1 and 2, Fig. 20, the follower found, on reaching the boundary fence beyond Sta. 2, that he had three arrows in his hand, representing three chain lengths. Counting from the last arrow, it is found that the chain as now laid down shows five tallies and six links to the boundary. The five tallies represent 50 feet and the six links 6 feet, as each link represents 1 foot. Therefore, the total length of the line is $300 + 50 + 6 = 356$ feet.

BOOKING THE DIMENSIONS

51. Field Book.—When chaining on the site, the notes, dimensions, etc., are usually taken in what is called a **field book,** which is about 8 inches long by $4\frac{1}{2}$ inches wide. Each page has a column running down its centre about $\frac{3}{4}$ inch wide. This column represents the chain line, and in it all the dimensions as taken by the chain are inserted. The columns to the right and left of this central column are used for marking down

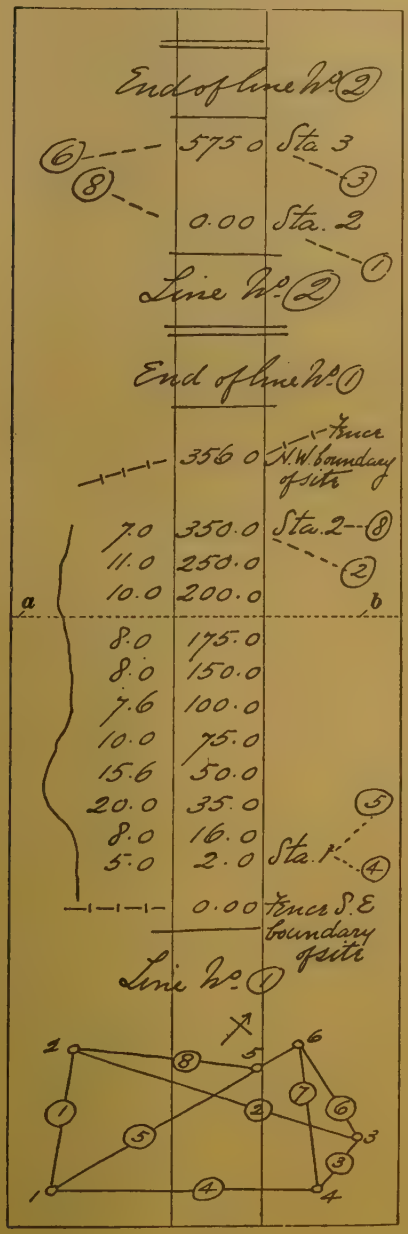


Fig. 22

the offsets and inserting the positions of buildings, fences, hedges, etc. When using a field book, commence on the last double page, at the bottom of which sketch the preliminary or sketch survey plan, as shown in Fig. 22, where a page of the field book is shown as it would be entered for an actual survey, the fold of the book being on the line *a b*. The same field is taken as was shown in Fig. 20, and the proper dimensions for the line through Stas. 1 and 2 are entered. After the preliminary sketch has been completed and the positions of the stations have been determined, each one must be numbered as shown. The lines must also be numbered, and a circle placed round each number to distinguish it from a station.

52. The name and date of the survey should always be clearly indicated in the book on the page before the sketch plan, and immediately above the sketch plan should be commenced the dimensions. The number of the line to be chained must be first inserted, in this case it is line *1*, then

the point at which the chaining is commenced, which is the fence on south-east boundary of the site. The follower usually books all dimensions and notes, holding the book in such a way that the central column represents the chain on the ground in direction, entering offsets in the book to the right or left of the central column as they occur to the right or left of the chain.

53. The first dimension noticed along the chain after it has been lined out along the line will be at Sta. 1. This is found to be 2 feet from the fence, so the dimension 2 feet is entered in the central column ; the words Sta. 1 are marked against it to show to what the dimension refers. To the left of the central column in the book is marked an offset showing the position of the south-west boundary at this point, and in the right-hand column is shown the direction of lines *5* and *4*, signifying that they both run from Sta. 1. The chain is still followed along its length and offsets are taken at distances of 16, 35, 50, 75, and 100 feet and entered as shown. Then the chain is drawn along as before described and offsets are taken as necessary and a rough outline of the boundary of the site is shown as well. When Sta. 2 is reached, particular note is made of it and also whether or not any other lines commence from it as determined by the sketch plan. If they do, their number and approximate direction are shown. Care should be taken to note the end of every line and the commencement of the next, also the number of the line to be chained should always be given before any dimension is put down.

FIELD PROBLEMS AND DIFFICULTIES

54. Chaining Down-Hill.—When chaining down-hill, the head end of the chain is raised as nearly as possible to the same level as the rear end. The leader then transfers the measurement from the elevated end of the chain by holding a range pole vertically, or by means of a plumb-bob, the string of which is held against the end of the chain. The chain should be drawn as taut as possible, in order to avoid the sagging of its centre part, the effect of sagging being to make the recorded measurements too long. If the slope of the ground is so great that the leader

cannot hold his end of the chain level with the rear end, the chain is *broken ;* that is, a part only of it is used in making the measurement. The leader should break chain at such a point that the part used will be as long as he can conveniently hold level with the rear end.

55. The process of chaining down-hill is shown in Fig. 19, where *B A* is the line to be measured. The leader draws out the chain to its full length, in the direction *B A*. Finding that he cannot hold his end level with *B*, he returns to a point that he can hold level, for instance, the fortieth link from the rear end of the chain. When this measurement is transferred to the ground at *D*, the follower, dropping his end of the chain, holds at *D* the point where the chain was broken, and the leader transfers the measurement from the end of the chain to the ground at *C*. This process is repeated until the total distance between *B* and *A* has been measured. In very steep slopes, it may be necessary to break chain several times in measuring a chain length. If arrows are used for marking intermediate points between two full chain lengths, they should be given or thrown to the leader as the follower advances from those points. The follower should keep only those arrows marking full chains.

56. Chaining Up-Hill.—When chaining up-hill, the process is reversed ; the follower holds his end of the chain directly over the point last occupied and marked by the leader, and raises it so that it will be level with the end held by the leader. The follower may keep his end of the chain over the proper point by using either a plumb-line or a range pole. An experienced chainman can estimate the proper position by the eye, with sufficient accuracy. The leader should draw the chain taut and mark the end of the measurement as soon as the follower, having put him in line, signals or calls to him that he is at the right position. This process is repeated as often as necessary. Care should be taken not to mistake the point where the chain is broken, taking, for instance, the fortieth for the sixtieth link. As it is much easier to chain down-hill than up-hill, it is often best, especially where the slope is very steep, to set a point in line at the top of the hill and then chain backwards from it.

57. Running a Line Over a Hill When Ends of Line Are Invisible From Each Other.—Suppose that it is desired to run a line between two points A, B, Fig. 23, on opposite sides of a hill and invisible from each other, or to determine the position of some intermediate points. Having set poles at A and B, two men with poles station themselves at C and D, approximately in line with A and B, and in such positions that the poles at B and D are visible from C, and those at C and A are visible from D. The man at C lines in the pole at D between C and B, and then the man at D lines in that at C between D and A. Then the man at C again lines in that at D, and so on, until C is in line between D and A at the same time that D is in line between C and B. The points C and D will then be in line with A and B.

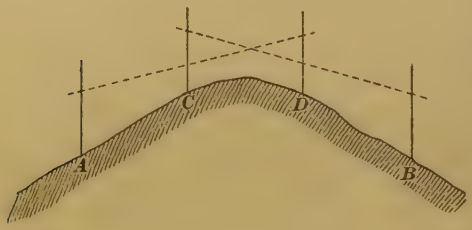


FIG. 23

58. To Erect a Perpendicular to a Line at a Given Point.—Let it be required to erect a perpendicular to the line $A\,B$ at the point B, Fig. 24. Since a triangle having sides in the proportion of 3, 4, and 5 is a right triangle, the longest side being the hypotenuse, for $5^2 = 4^2 + 3^2$, set off on the line $B\,A$, Fig. 24, a distance of 30 feet, or links. Fix one end of the chain at one of the extremities of $B\,C$, and the end of the ninetieth link at the other extremity. Hold the end of the fiftieth link and draw the chain until both parts are taut. The point D where the end of the fiftieth link is held will then be a point in the perpendicular, and the direction of the latter will therefore be $B\,D$.

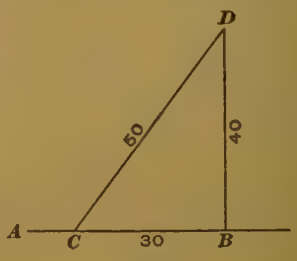


FIG. 24

The distance $B\,C$ may be any other convenient multiple of 3. In general, if $B\,C$ is denoted by $3\,a$, $B\,D$ must be $4\,a$, and $C\,D$

must be 5 a. Thus, $B\,C$ may be made equal to 21 ($= 3 \times 7$) links; in which case $B\,D$ must be $4 \times 7 = 28$, and $C\,D$ must be $5 \times 7 = 35$, links. As $35 + 28 = 63$, one end of the chain must be fixed at one of the extremities of $B\,C$, the end of the sixty-third link at the other extremity, and the chain pulled from the end of the thirty-fifth link until both parts are taut.

59. To Drop a Perpendicular to a Line From a Point Without. In Fig. 25, let P be a point without the line $A\,B$ from which it is desired to drop a perpendicular to the line. Estimate, by eye, the point at which the perpendicular will meet $A\,B$. Then at this point C, as just described, erect a perpendicular $C\,R$ to $A\,B$ and prolong it a short distance past P; then measure its distance $P\,D$ from P. As $C\,R$ is not far from P, the point D directly opposite P can be determined by eye with sufficient accuracy. Measuring from C a distance $C\,E$ equal to $D\,P$, the point E, where the perpendicular from P meets $A\,B$, is determined.

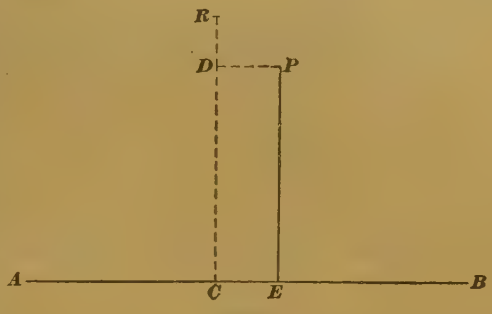


FIG. 25

60. To Run a Line Parallel to Another.—Let $A\,B$, Fig. 26, be a line to which a parallel through a given point P is to be run. Drop a perpendicular from P to $A\,B$. Let C be the point where this perpendicular meets $A\,B$. Measure $C\,P$. At some other point D in the line $A\,B$, erect a perpendicular to the latter line. Measure on this perpendicular a distance $D\,Q$, equal to $C\,P$. A line through P and Q will be the required parallel.

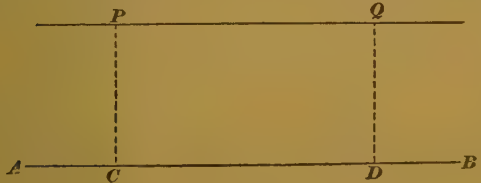


FIG. 26

61. To Prolong a Line Through an Obstacle.—In prolonging a line $A\ B$, Fig. 27, suppose that an obstacle K, as a building, makes it impossible to run and measure the produced line directly.

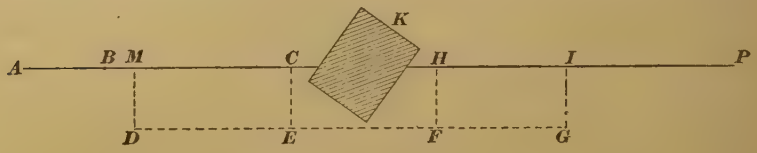


Fig. 27

The line $A\ B$ is then produced to a point C as near the obstacle as possible; a perpendicular $C\ E$ is erected at C, and its length $C\ E$ made long enough to clear the obstacle. At a point M 30 or 40 feet from C another perpendicular to $A\ C$ is erected, and a distance $M\ D$ equal to $C\ E$ is measured on it. The points D and E determine a line parallel to $A\ C$. This parallel is prolonged beyond the obstacle, and at two points F and G, the former just beyond the obstacle and the latter about 30 or 40 feet from it, perpendiculars are erected, on which distances $F\ H$ and $G\ I$ are measured equal to $C\ E$ and $M\ D$. The points H and I thus determined are in the prolongation of $A\ B$. The distance $C\ H$ is equal to $E\ F$, which should be measured.

62. To Determine the Distance to an Inaccessible Point.—In Fig. 28, let it be required to determine the distance from the point B to an inaccessible point P. Measure $B\ C$ in any convenient direction in which it will form one side of as nearly a regular triangle as possible, of which P will be the apex, and run a line $A'\ D'$ parallel to $B\ C$. Measure the distance $A\ D$ between the points where the lines $P\ B$ and $P\ C$ intersect $A'\ D'$. Measure also $A\ B$. Then,

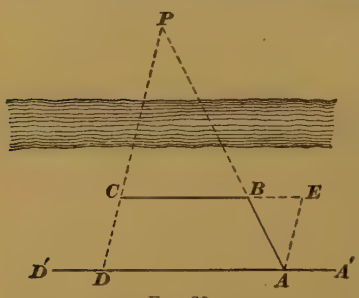


Fig. 28

$$B\ P = \frac{A\ B \times B\ C}{A\ D - B\ C}.$$

The derivation of this equation is as follows: Draw AE parallel to DP, and intersecting CB produced at E. Then, the angles of the triangle BCP being equal to those of the triangle ABE, these two triangles are similar, and therefore $\frac{BP}{AB} = \frac{BC}{BE}$; whence,

$$BP = \frac{AB \times BC}{BE}$$

or, because $BE = AD - BC$,

$$BP = \frac{AB \times BC}{AD - BC}$$

EXAMPLE.—If, in Fig. 28, $BC = 100$ feet, $AB = 52{\cdot}4$ feet, and $AD = 124{\cdot}2$ feet, what is the distance BP?

SOLUTION.—Substituting these values in the equation just given,

$$BP = \frac{52{\cdot}4 \times 100}{124{\cdot}2 - 100} = 216{\cdot}5 \text{ ft.} \quad \text{Ans.}$$

63. To Determine by a Random Line the Distance Between Two Points That Are Invisible From Each Other.—When the extremities A, B, Fig. 29, of a line, the distance of which is to be determined, are known and fixed, but are not visible from each other on account of some obstruction to the line of sight, the distance AB is determined by means of an auxiliary line AD', called a **random line.** This line is run from one of the extremities, A in this case, of the given line, in such a manner that it

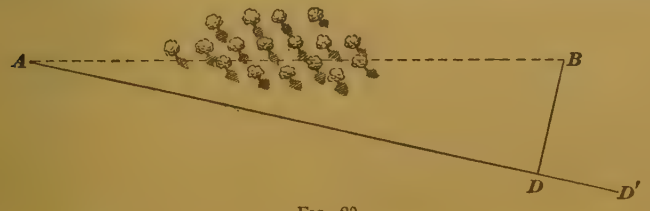


FIG. 29

will pass as near the other extremity as can be estimated. From this other extremity a perpendicular is dropped on the random line, and the required distance is computed by solving a right triangle. In the present case the perpendicular BD from B to AD' is measured, the distance AD is noted, and the distance AB is given by the equation $AB = \sqrt{AD^2 + BD^2}$.

EXAMPLE.—If, in Fig. 29, the distance $A\,D$ is 206·1 feet and the distance $B\,D$ is 35·1 feet, what is the distance from A to B ?

SOLUTION.—Here $A\,D = 206{\cdot}1$, $B\,D = 35{\cdot}1$, and therefore, substituting in the equation,

$$A\,B = \sqrt{206{\cdot}1^2 + 35{\cdot}1^2} = 209\ 1 \text{ ft.} \quad \text{Ans.}$$

EXAMPLES FOR PRACTICE

64. 1. If the distances $C\,B$, $C\,D$, and $D\,A$, Fig. 28, are, respectively, 75, 42, and 103 links, what is the distance $C\,P$? Ans. 1·13 ch., nearly

2. Two points A and B are invisible from each other. A random line being run from A, it is found that its distance from B is 12·6 feet; if the distance from A to the foot of the perpendicular is 192·5 feet, what is the distance from A to B? Ans. 193 ft., nearly

COMPLETE SURVEY OF A FIELD

TAKING MEASUREMENTS

65. Preliminary Sketch.—In Fig. 30 is shown a preliminary sketch plan of a field that must be accurately measured by chaining. The scheme of triangulation has been set out on the plan, the station points indicated by poles on the site have been fixed and are numbered from *1* to *4*, while the chain lines have been numbered from *1* to *6* and are enclosed in circles. The field is bounded on the north and west sides by a post-and-rail fence, on the south side by a footpath, and on the east side by a bank. There is a footpath running across the north-west corner of the site, and a small enclosure is formed on the north-east corner by means of a post-and-rail fence.

66. Chaining.—The chaining will be commenced from Sta. 1, and the dimensions will be entered in the book as shown in Fig. 31. The leader will draw the chain along past Sta. 1 toward Sta. 2, and the follower will hold his end at the north edge of the footpath by Sta. 1. When the chain is lined up and an arrow is inserted, the follower commences to book the dimensions. He will first make a note that it is line *1* that is being measured, as shown in Fig. 31 (*a*). Then his starting point will be booked

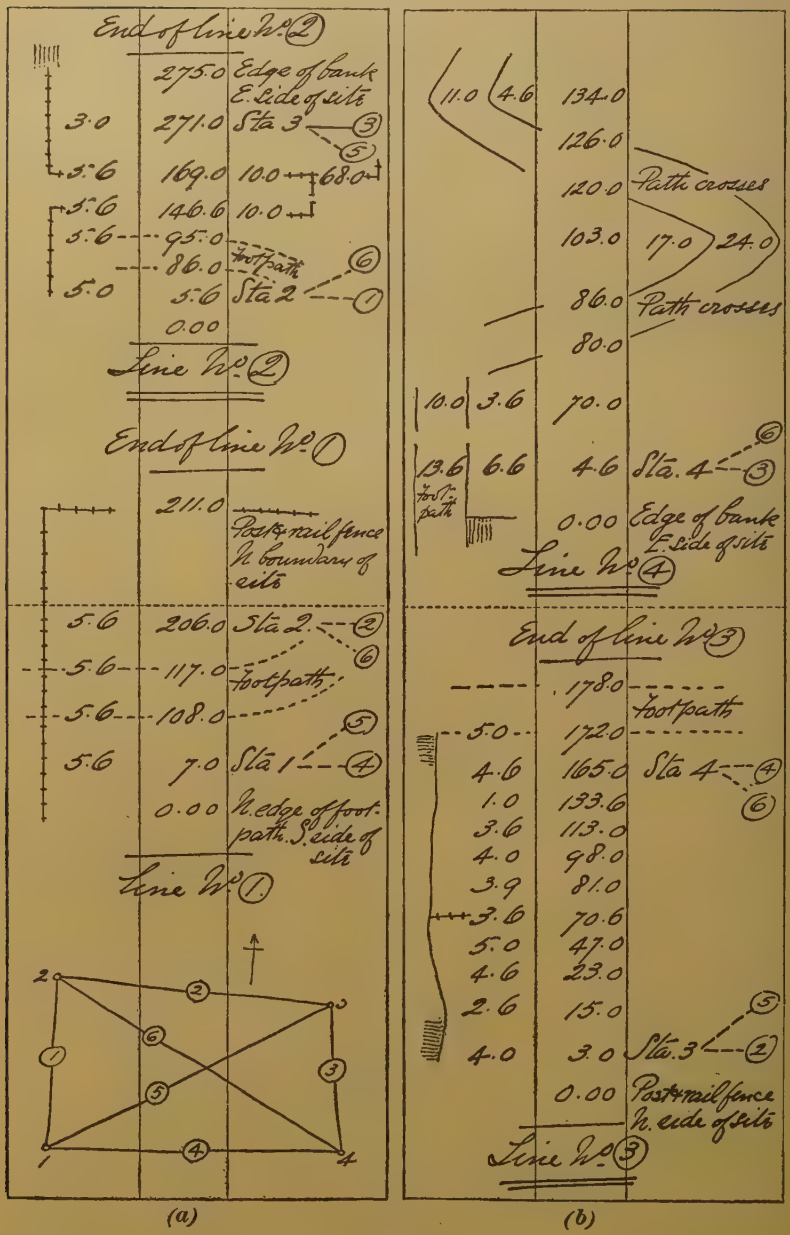
as "N. edge of footpath S. side of site." The figures 0·00 inserted in the dimensions column opposite this note shows it is the commencement of the chain.

67. The first dimension taken will be at Sta. 1, which is 7 feet along the chain; this is booked, the direction of lines *5* and *4* running from it are shown, and the offset to the fence on the left-hand side of the line is taken and booked. The distance at which the footpath crosses the line *1* is measured and booked together with offsets on the left-hand side, as shown.

FIG. 30

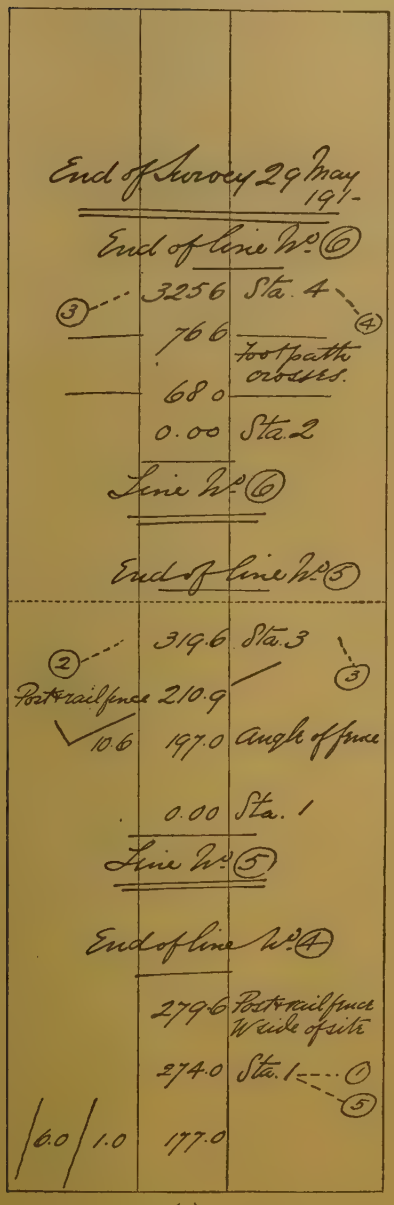
Sta. 2 is next booked, and the direction of lines *2* and *6* indicated as before. Then the dimension to the post-and-rail fence on the north boundary of the site will complete the measurements necessary on line *1*. A line should be drawn across the dimensions column in the book, the words "end of line No. 1" will be written, and two lines drawn over to show that the line *1* is complete, as shown in Fig. 31 (*a*).

68. The next line to be measured will be line *2*; this will be commenced from the western boundary next Sta. 2, and the


End of line No 2
275.0 Edge of bank E. side of site
3.0 271.0 Sta 3
3.6 169.0 10.0 68.0
3.6 146.6 10.0
3.6 95.0
86.0 Foot path
5.0 5.6 Sta 2
0.00
Line No 2
End of line No 1
211.0 Post & rail fence N. boundary of site
5.6 206.0 Sta 2
5.6 117.0 Foot path
5.6 108.0
5.6 7.0 Sta 1
0.00 N. edge of foot-path. S. side of site
Line No 1
11.0 4.6 134.0
126.0
120.0 Path crosses
103.0 17.0 24.0
86.0 Path crosses
80.0
10.0 3.6 70.0
13.6 6.6 4.6 Sta. 4
For Si path
0.00 Edge of bank E. side of site
Line No 4
End of line No 3
178.0
Foot path
5.0 172.0
4.6 165.0 Sta 4
1.0 133.6
3.6 113.0
4.0 98.0
3.9 81.0
3.6 70.6
5.0 47.0
4.6 23.0
2.6 15.0
4.0 3.0 Sta. 3
0.00 Post & rail fence N. side of site
Line No 3
1
2
3
4
5
6

(a) (b)

FIG. 31



(c)

FIG. 31 (*Continued*)

first point to be measured and booked will be Sta. 2. The dimensions for the whole of this line are shown in Fig. 31 (*a*). The position where the footpath crosses must be noted, as also where the fence runs into the site to form the enclosure in the north-east corner. The notes show that the first portion of the fence crosses the line at the distance of 146 feet 6 inches from its commencement, and the angle of the fence shown in Fig. 30 is 10 feet to the right, while it joins the main fence 5 feet 6 inches to the left of the line. The fence again crosses the line at a point 169 feet from the commencement of the line. There are two offsets to the right of the dimension 169 feet shown in Fig. 31 (*a*); one refers to the point where the recessed portion of the main fence meets the enclosure fence, and the other shows that the angle of the enclosure fence is 68 feet to the right of the chain line. The chaining on this line can now be completed by continuing to Sta. 3 and to the edge of the bank, the dimensions necessary being booked as shown in Fig. 31 (*a*).

The measurements necessary on lines *3* and *4* will then be

completed and entered as shown in Fig. 31 (*b*) and (*c*), when the only remaining measurements to be taken are those on lines *5* and *6*. The booking of all these dimensions is shown in Fig. 31 (*a*), (*b*), and (*c*). When the last line has been measured and all the dimensions necessary to complete the survey have been taken and booked, a note " end of survey " should be made as shown, and the date should be added. Care should be taken before leaving the field that all the instruments, books, etc., that were brought from the office are accounted for, as it is often found, if this is not done, that an arrow or some other article has been forgotten.

PLOTTING THE DIMENSIONS

69. The next step is to make the drawing to scale of the survey, from the dimensions taken and shown in Fig. 31. The method adopted is very similar to that adopted for plans of houses, except that the dimensions are generally longer, and may necessitate the use of special compasses, termed *beam compasses*. These are composed of two special needle, pencil, or pen points that can be clamped by means of screws to a long straightedge or *beam*. The dimensions really should be plotted exactly in the order they were taken on the site. The first line to draw after having decided to what scale the survey is to be plotted is the line *1*. The triangles must first be plotted, but without the offsets. Draw line *1* to scale and approximately in the direction in which it occurs in the sketch survey. Mark off on this line two points *1* and *2* to represent Stas. 1 and 2. The dimensions given in Fig. 31 (*a*) show that Sta. 2 is 206 feet along line *1* from the north edge of the footpath on the south side of the site ; but Sta. 1 is 7 feet from the same edge of the site, so the distance between Stas. 1 and 2 is 206 feet — 7 feet, or 199 feet. Set out to scale on the line already drawn the distance 199 feet, and mark one end of it Sta. 1 and the other Sta. 2, to agree with the sketch survey plan.

70. With Sta. 1 as a centre and a radius of 319 feet 6 inches, the length of line *5*, to scale draw an arc about where Sta. 3 will come. With Sta. 2 as a centre and a radius of 265 feet 6 inches,

cut the arc previously drawn, and mark the point so found as Sta. 3. The dimension of 265 feet 6 inches is the length of line *2* between Stas. 2 and 3 obtained from the dimensions in Fig. 31(*a*) by deducting 5 feet 6 inches from 271 feet. With Sta. 3 as a centre and a radius of 162 feet, the length of line *3* obtained from (*b*), draw an arc about where Sta. 4 will come, and cut this arc by another drawn with Sta. 2 as a centre and a radius of 325 feet 6 inches, the length of line *6*. Now, if the working so far has been correctly done, the distance between Stas. 4 and 1 should scale exactly 269 feet 6 inches, which is the length of line *4* between Stas. 4 and 1 according to the dimensions. If this does not scale correctly, the whole of the plotting should be gone over again correctly, and checked and redrawn until this line *4* does scale exactly in accordance with the dimensions.

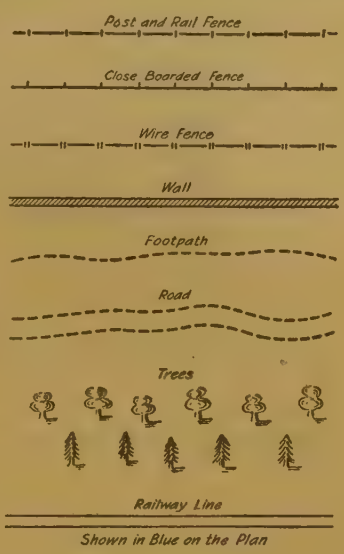


FIG. 32

71. When the lines and stations are plotted correctly, the outline of the site may be drawn in. Commence with the outline on line *1*. The dimensions in Fig. 31 (*a*) show that Sta. 1 is 7 feet from the edge of the footpath on the south side of the site, so produce line *1* backwards through Sta. 1 and mark off 7 feet from Sta. 1 to obtain the position of the edge of the footpath. It must be carefully noted that all dimensions along line *1* are set off from this point at the edge of the footpath. The first offset is at Sta. 1, which is measured to the left of Sta. 1 a distance of 5 feet 6 inches at right angles to line *1*. Then measure along

this line *1* distances of 108 feet and 117 feet from the north edge of the footpath on the south side of the site, as these two points are where the footpath running across the north-west corner of the site crosses the line.

72. All the offsets to line *1* are 5 feet 6 inches, so this boundary is parallel to line *1* throughout its length. At 206 feet along this line is Sta. 2, which has already been fixed, and the only remaining dimension to be plotted is that of 211 feet to the boundary on the north side of the site. In a similar manner lines *2*, *3*, and *4* can be dealt with, and, when the boundary has been completed, the chain lines can be rubbed off the drawing or can be inked in as required. On a finished survey plan they are often inked in in red ink.

73. Any survey that may have to be undertaken resolves itself into a number of problems such as the one that has now been worked out. In the completion of the plans and in the survey notebook a number of conventional signs are used by surveyors for representing various surface features. A few of the more common of these are shown in Fig. 32.

LEVELLING

METHODS EMPLOYED

DEFINITIONS

74. **Levelling** is the operation of determining the vertical heights of points above some horizontal plane adopted as a *datum*. In surveying work, levelling is conducted principally for the following purposes: (*a*) To determine the difference in elevation between two or more points; (*b*) to determine the elevations of the ground along any desired line, for the purpose of obtaining a *section* along that line, so that when making the working drawings of a building the levels of the various floors may be determined correctly in relation to the ground on which

the building is to be erected, and the correct number of steps at the various entrances fixed.

75. Datum. — Wherever convenient, the Ordnance datum, which is the plane of mean sea level at Liverpool, is taken as the **datum** or **zero plane,** in calculating elevations, although any other plane, whether real or imaginary, may be taken as the basis of operations. The **elevation,** or **height,** of a point is its distance vertically above a given level surface. Unless otherwise specified, the elevation of a point means its vertical height above mean sea level. Any line in the assumed datum plane to which the elevations of points in a given plane are referred is called a *datum line.*

76. Assumed Elevation of Starting Point.—The relative elevations of the various points may be ascertained without any regard to their absolute elevations. In order to have a convenient basis of comparison on which to obtain the relative elevations of the various points, it is customary to assign an assumed elevation to some one of the points, usually the starting point. It is of little importance what elevation is assumed, except that the starting point should be taken far enough above datum, or, in other words, the position of the assumed datum should be far enough below the starting point, so that no point in the line of levels will be liable to fall below the assumed datum. If any point in the line of levels were to fall below the datum, its elevation would be expressed as a minus quantity, and this would cause unnecessary inconvenience in keeping the notes. For short lines of levels in ordinary country, it is quite customary to assume the elevation of the starting point to be 100 feet above datum ; but in rough country or for an extended line of levels, in order that no point may fall below datum, it will be necessary to assume a greater elevation for the starting point ; an elevation of 1,000 feet is not uncommonly taken.

77. Methods of Levelling. — The three general methods of determining elevations, which differ essentially with regard to the principles involved and the instruments and processes used, are : (*a*) *spirit levelling*, (*b*) *trigonometric levelling*, also called

indirect levelling, and (*c*) *barometric levelling*. The third method has to do mainly with prospecting and preliminary work and is not adapted to accurate levelling. The method adopted by architects and surveyors is that of spirit levelling.

SPIRIT LEVELLING

GENERAL PRINCIPLES

78. In **spirit levelling**, the elevations of any number of points are determined by measuring their respective distances vertically above or below a level line or series of level lines whose elevations above the given datum plane are known. Each level line is prolonged horizontally from a point of known elevation, so as to pass directly over or under the point whose elevation is required, and the distance of the point vertically below or above the level line is measured. The elevation of each required point being determined in this way, the difference in the elevations of any two points is found by subtracting the elevation of the lower from the elevation of the higher.

The name **direct levelling** is sometimes applied to this method, because the elevation of each point is determined by measuring directly its distance vertically above or below the horizontal line of sight. The device most commonly, and almost universally, employed for determining when a line is horizontal is the *spirit level*.

SURVEYORS' WYE LEVEL

79. **Essential Parts.**—The most highly developed form of the spirit level is the **surveyors'**, or **engineers', level.** This instrument is used more extensively than any other for determining elevations, and by means of it results of exceeding accuracy are obtained. There are two kinds or general classes of surveyors' level, the **Y** *level* and the *dumpy level;* with both levels similar results are obtained. In Fig. 33 is shown a **Y level**, so called on account of the **Y**-shaped supports for the telescope. It consists essentially of the *telescope e d*, the *spirit level f f'*, the *tripod*

head g, and the various parts for attaching the level and telescope to the tripod head, and for adjusting, levelling, and sighting the instrument. By means of the *levelling screws h*, the line of sight can be made truly horizontal, that is, perpendicular to a plumb-line at the point at which the level is set.

80. Telescope.—In the telescope, *e* is the *eyepiece* and *o* the *object glass ; m* is a milled-headed pinion, fitting a rack on the inside of the telescope tube, by means of which the position of the object glass can be adjusted. The position of the eyepiece *e* is also adjustable. On the inside of the telescope tube at *x* are the *cross-hairs*, or *cross-wires*, in the plane of which the image of the object observed is focused by the object glass. The position of the cross-hairs, with reference to the optical axis of the telescope, is adjusted by means of four small capstan-headed screws *x*. The axis of the eyepiece is adjusted, or centred, by means of the grooved-headed screws *a*.

81. Supports and Parallel Plates.—The telescope is supported on the **Y**-shaped standards *y*, *y'*, Fig. 33, called *wyes*, in which it is firmly held by the clips *i*, *i'*, which fit into the collars *c* and are fastened by the small tapering pins *j*, *j'*. The wyes are securely attached to the horizontal level bar *k k*, and one wye is adjustable by means of capstan-headed screws. The bar *k k* is rigidly attached to a steel spindle, called the *centre*, fitting very accurately into a socket *l*, which is firmly attached to the upper parallel plate *n*. The lower end of this socket connects, by means of a ball joint, to the lower parallel plate *n'*, which is usually screwed to the tripod head *g*. The plates *n* and *n'* are called the *parallel plates*, though they are seldom really parallel ; they are also sometimes called the *levelling plates*.

The position of the upper parallel plate, which carries the spindle socket and determines the position of all the upper portion of the instrument, is adjusted by means of four milled-headed levelling screws *h* ; it is by means of these four screws that the instrument is accurately levelled when in use. In some levels there are only three screws, arranged at points between the plates equivalent to the apexes of an equilateral triangle. By means of the thumbscrew *r*, the spindle can be clamped

in any position in its socket, thus fixing the direction of the telescope, which may then be slowly turned horizontally by means of the tangent screw *u*.

82. **Spirit Level.**—The attached spirit level *f f'*, Fig. 33, is a thick glass tube, or vial, slightly curved upwards so that the centre is higher than the ends. It is so nearly filled with alcohol, or a mixture of ether and alcohol, as to contain only a small long bubble of air, and is permanently sealed and fixed in a metal case

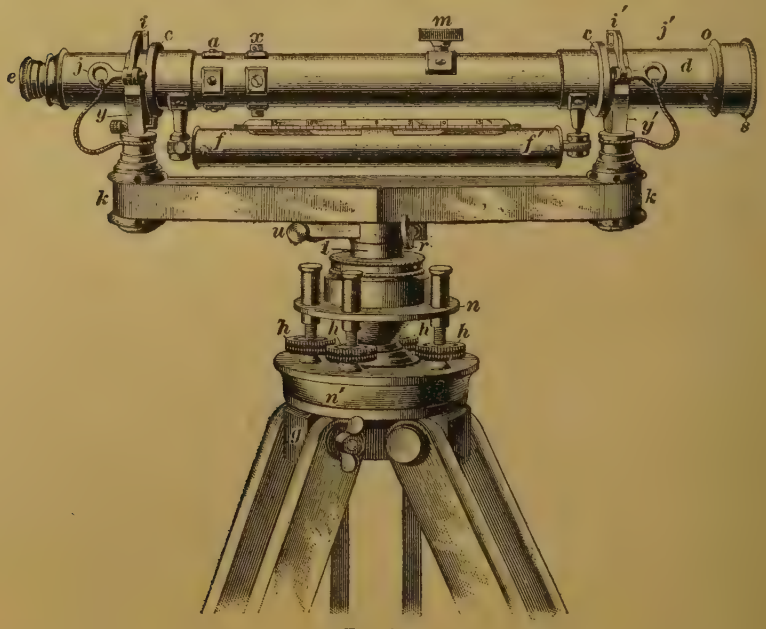


FIG. 33

having an opening in the top. The sensitiveness of the level depends on the amount of curvature in the bubble tube, and decreases as the curvature in the tube increases. The interior of the tube, or at least the upper portion of it, is ground perfectly cylindrical and to a regular curve. The bubble of air left within the tube will always seek the highest point, and will, by its movements, indicate any change in the horizontality of the tube; when the tube is in a nearly horizontal position, the slightest change will give considerable movement to the air bubble.

83. Above the opening in the metal case which encloses the spirit level, and through which the level tube and the movement of the air bubble can be seen, is placed a scale containing the same graduations and numbers each way from the centre. By means of this scale, the position of the air bubble, with reference to the centre, may readily be seen. The graduations are sometimes made directly on the glass tube. In order that the level may be so adjusted that a line tangent to the curved inner surface of the tube at its centre will be parallel to the axis of the telescope, the metal tube in which the level is enclosed can be adjusted both vertically and laterally by capstan-headed screws at the ends of the tube. By means of the screws near the eye-piece, that end of the bubble tube can be moved sidewise, and by means of the screws at the other end, that end of the tube can be raised or lowered.

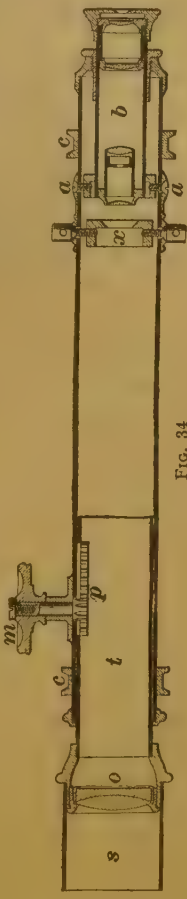


Fig. 34

84. Parts of Telescope. — In Fig. 34 is shown a longitudinal section of the telescope *e d* of Fig. 33. The object glass *o* is composed of two lenses, one being a double-convex and one a plano-concave lens. One lens is commonly made of crown glass, and the other of flint glass. This combination of lenses for the object glass has been found necessary in order to render it achromatic, that is, so that it will not show colour by the decomposition of light. The object glass is not attached to the telescope tube proper, but to a slightly smaller tube *t*, which is accurately fitted into the end of the telescope tube. In order that the image may be focused exactly on the cross-hairs at *x*, the tube containing the object glass is made to slide in and out by means of the pinion *p*, working in a rack attached to the object-glass slide, and operated by the milled head *m*. When

the telescope is used in the sunshine, the object glass is protected by a sunshade *s*, which is detachable, and is generally removed when the weather is cloudy. When not in use, the object glass is protected by a metal cap which fits over it. The cross-hairs in a telescope are made of fine platinum wires, or of spider threads, attached to a ring *x*, suspended within the telescope tube by four screws.

85. The eyepiece *b*, Fig. 34, magnifies the image projected at *x* by the object glass. It consists of four lenses arranged as shown. To accommodate individual peculiarities of vision, such as short-sightedness and long-sightedness, the eyepiece may be moved in and out a small amount, by pushing or turning it with the hand or by means of a rack-and-pinion movement, similar to that for the object-glass slide. The eyepiece is centred for the image by means of groove-headed screws *a*. This adjustment is omitted by some instrument makers, who claim that if the instrument is accurately made, subsequent adjustment of the axis of the eyepiece is unnecessary.

86. Collars on Telescope.—On the outside of the telescope tube, and near its respective ends, are two rings, or collars, *c*, Fig. 34. These collars serve as bearings on which the telescope rests in the wyes, and are generally composed of bell metal. They must be turned truly circular, and must be of exactly the same external diameter. A straight line passing through the centres of these two collars is the horizontal axis of rotation of the telescope. On the accuracy of the bearings of these collars depends, to a considerable extent, the accuracy of the instrument; for, unless the collars are perfectly circular and of exactly the same size, the level cannot be adjusted accurately by the methods commonly used. The collars do not rest in the wyes throughout their lower semi-circumference. As the collars are perfectly circular and the wyes are **Y**-shaped, the collars rest in the wyes on two small areas of contact, for which very accurate bearings can be obtained.

87. Instrument Centre.—The centre, or spindle, by which the horizontal level bar is connected to the upper parallel plate, is

a solid piece of metal, generally about 3 inches long and slightly conical. The metal is preferably steel, and should be turned very accurately to fit the socket, which should be composed of a different metal, generally brass. The arrangement of the parallel plates, and the four milled-headed levelling screws by which the position of the upper plate is adjusted, are shown in Fig. 33.

88. Axis of Revolution.—Besides the axis of rotation of the telescope, the level has an axis of revolution which is the vertical axis of the instrument. When a level is in adjustment and is levelled up, the line of sight revolves on this axis in a horizontal plane. This *line of sight*, when in adjustment, is also called the *line of collimation ;* it is the line determined by the intersection of the cross-hairs and the optical centre of the object glass. When properly adjusted, this line coincides with the axis of rotation of the telescope. In the use of the level, the only essential requisite to accurate work is that this line of sight shall revolve in a horizontal plane, and that this condition shall be indicated by the bubble remaining in the centre of its tube when the telescope is revolved.

ADJUSTMENTS OF WYE LEVEL

89. First Adjustment.—*To make the line of collimation coincide with the axis of rotation of the telescope.*

Plant the tripod firmly ; choose some distant and clearly defined point, the more distant the better, so long as the sight is distinct. Clamp the spindle and remove the pins j, j' from the clips i, i', Fig. 33 ; then, by means of the tangent screw u, bring the intersection of the cross-hairs to bear exactly on the point chosen. Revolve the telescope in the wyes until the bubble tube is on top. If the intersection of the cross-hairs is still on the point of sight, the line of collimation coincides with the axis of rotation. If the intersection is not on the point of sight, move the cross-hairs by means of the capstan-headed screws x over one-half the space of the error, being careful to move them in the opposite direction to that in which it would appear they

should go, then revolve the telescope until the tube is underneath again. Repeat the operation until the adjustment is satisfactory.

90. Second Adjustment.—*To make the axis of the attached level parallel to the line of collimation.*

Remove the pins j, j', Fig. 33, and open the clips i, i'; turn the telescope until it is over a pair of levelling screws and clamp the spindle by means of the thumbscrew r. Bring the bubble to the middle of its tube by turning this pair of levelling screws. Then revolve the telescope in its wyes through an eighth of a revolution, which will make the bubble tube stand at an angle with the wyes. If the bubble has moved toward one end of its tube, it shows that the longitudinal axis of the bubble tube and the axis of rotation of the telescope, or the line of collimation, do not lie in the same plane. To correct the error, bring the bubble half-way back by means of the check-nuts which regulate the lateral movement of the tube, and bring it the rest of the way by means of the levelling screws. Repeat the operation until the bubble ceases to run when the partial revolution is made.

To complete the bubble adjustment, level the telescope, take it out of the wyes, and replace it end for end. If the bubble remains in the centre of the tube, the second adjustment is complete. If it moves toward one end, bring it half-way back by means of the check-nuts provided for raising or lowering one end, and bring it the rest of the way, that is, to the middle of the tube, by means of the levelling screws. Repeat the operation until the adjustment is satisfactory.

91. Third Adjustment.—*To make the axis of the telescope, or the line of collimation, perpendicular to the spindle, so that the bubble will remain at the centre of the tube while the telescope is revolved horizontally.*

Fasten down the clips i, i', Fig. 33, unclamp the spindle, and bring the bubble to the centre over each pair of levelling screws in succession. Revolve the telescope 180° horizontally and correct one-half of the movement of the bubble by the locknuts at the end of the level bar, and the remainder by the levelling screws h. Repeat the operation, as several trials may be necessary to make the adjustment exact. The adjustments of a level

in constant use should be tested daily, as any derangement will detract from the accuracy of the work that is done, while it may be so much in error as to render all work absolutely valueless.

SURVEYORS' DUMPY LEVEL

92. Description.—The surveyor's dumpy level is very similar to the wye level, except that in the dumpy level the telescope is attached rigidly to the horizontal level bar, and cannot therefore be lifted from its base, as in the wye form. The level tube is attached to the telescope and on top of it, instead of underneath. Since the telescope in a dumpy level cannot be revolved in its supports, there is no necessity for a lateral adjustment of the level tube. The other parts of a dumpy level, the levelling screws and tripod, are similar to the wye level, and will require no special description.

93. Adjustments.—There are two adjustments of the dumpy level, namely: (*a*) To make the axis of the level tube perpendicular to the vertical axis of rotation, so that the bubble will stand in the centre of its scale when the telescope is revolved. (*b*) To make the line of sight parallel to the axis of the level tube, so that the line of sight will be horizontal when the level bubble stands in the centre of its scale.

94. First Adjustment.—*To make the axis of the level tube perpendicular to the vertical axis of rotation.*

This adjustment having been made, the bubble will stand in the centre of its scale when the telescope is revolved. This is the same as the third adjustment of the wye level. Plant the tripod firmly and level up the instrument, using both pairs of levelling screws. With the telescope over one pair of levelling screws, centre the bubble accurately, then reverse the telescope end for end over the same pair of levelling screws. If the bubble runs toward either end, bring it half-way back by means of the capstan nuts at one end of the level tube, then centre it with the levelling screws. Repeat the operation over each pair of levelling screws alternately until the bubble will remain centred perfectly throughout a complete revolution of the telescope.

95. Second Adjustment.—*To make the line of sight parallel to the axis of the level tube.*

When this condition is attained the line of sight will be horizontal when the level bubble is centred. This method performs directly what is accomplished indirectly by the first and second adjustments of the wye level. It is sometimes called the **direct method** of adjusting the line of sight parallel to the axis of the level tube, but is very commonly known as the **peg method** of adjustment.

96. Drive two pegs in the ground 100 or 200 feet apart and set up the instrument either midway between them or at the same distance from each. The distances need not be measured with great exactness. With the bubble centred accurately, sight on the levelling staff, which will be described later, and note the reading at each peg. The difference in the readings of the staff at the two pegs is the true difference in the elevations of the pegs, whether the instrument is in adjustment or not. Next, set up the instrument over one peg with its centre at a distance from the peg horizontally equal to about one-half the length of the telescope ; bring the level bubble to the centre of the tube, and with the levelling staff measure the exact height of the intersection of the cross-hairs above the peg. To determine this height on the staff, hold the graduated face of the staff about $\frac{1}{2}$ inch from the eye end of the telescope, and by looking into the object end of the telescope bring the point of a pencil in the centre of the small field of view on the face of the staff. Or it can be determined closely by measuring to the middle of one of the horizontal adjusting screws to the cross-hairs. Make a careful note of this height, plus or minus the difference in the elevations of the pegs, according as the rod reading on the distant peg was more or less than on the peg over which the instrument is set ; then direct the telescope toward the rod held on the distant peg, and adjust the cross-hairs so that the horizontal cross-hair will exactly bisect the mark above noted when the level bubble stands in the middle of its scale. If the ground is sufficiently level, it is more convenient to drive both pegs to the same elevation, as determined by the level when set up

between them. In order to do this, drive one peg and read the staff held on that peg; then, with a note made of this reading, drive the other peg until the cross-hairs just bisect the level noted.

97. Instead of setting up directly over one peg, it may sometimes be more convenient to set up near it, for instance, from 10 to 20 feet from it, and determine the elevation of the cross-hairs above it by sighting at the staff held on the peg. After sighting at the staff held on the distant peg and nearly completing the adjustment, sight again at the staff held on the nearest peg and repeat the operation until the adjustment is found to be perfect. To obtain a perfect adjustment may take some considerable time. Many surveyors do not trouble about adjusting their levels in this way; but if they are known to be out of adjustment, they send them to the makers to have them put in order.

STAFFS

LEVELLING

98. Kinds of Staffs.—A levelling staff is usually a graduated wooden rod used to measure the vertical distance from the line of sight of a levelling instrument to any given point or station. There are two classes of levelling staffs in common use, namely: (*a*) **Self-reading staffs,** on which the graduations are sufficiently large and distinct to be read directly to tenths and hundredths of a foot through the telescope of the instrument; (*b*) **target staffs,** on which the graduations are small and the readings are taken by means of a sliding metal plate called a target. Self-reading staffs are used almost exclusively by architects in levelling.

99. Self-Reading Staff. — The most common form of self-reading staff is shown in Fig. 35. This staff is made in three sections, which telescope into each other for convenience in carrying. The outside section is marked up to 5 feet, and the staff, when fully extended, scales 14 feet. Each inside section is fitted with a spring catch, which, when fully extended, locks the two sections in their proper positions for continuous reading.

The lower extremity of the outside section is fitted with a brass plate, bent so as to form a flat shoe. The top of each section is clamped with a brass collar and the lower section has a strengthening collar in the centre.

100. Graduations.—The graduations on the staff start at the bottom of the outer section and read upwards through the two inner sections to 14 feet continuously, when the inner sections have been pulled out, till the spring catch has locked them. Each foot is divided into 100 divisions. The large figures on the left indicate the feet and are marked in red, the top of the figure being at the foot-mark. The odd figures on the right are the tenths of the foot, the top of the figure being the odd tenth and the bottom of the figure the even tenth. If, therefore, the hair cuts through one of these figures the tenth is even, and if it lies between two of these figures it gives an odd tenth. The horizontal lines show the hundredths, the top of a line being even and the bottom odd. The ·05 point, therefore, is the lower edge of the semi-extended line. The reading *a*, Fig. 35, is 1·37 feet, while the reading *b* is 1·24 feet. With practice, this form of graduation is the most accurate for self-reading; but, at first, considerable care must be taken to ensure that the correct figures are read off, especially in the case of an inverting telescope.

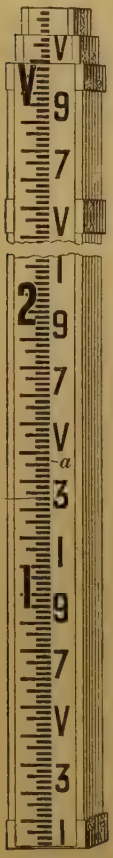


FIG. 35

101. Use of Staff.—The staffman is the man who carries the staff and holds it while a sight is being taken with the level. More mistakes are made in reading the number of feet than in reading the smaller divisions. The leveller by first calling the reading to the staffman will be certain to prevent such an error, as it would at once be detected in the check-reading. The staff should always be held truly vertical, or plumb, when it is being sighted. An experienced staffman can hold a staff practically

plumb, however, by balancing it as nearly as possible, and for all ordinary work his care is considered sufficient, though it is difficult for him to plumb the staff accurately in a heavy wind.

102. Plumbing the Staff.—The staff can be plumbed in the direction across the line of sight if the leveller will observe whether it coincides with the vertical cross-hair of the instrument. If it does not, he should indicate the direction in which it should be moved by raising his right hand over his head and moving it to the right, or raising his left hand and moving it to the left, as the case may be. Whether or not the staff is plumb in the direction of the line of sight cannot be distinguished from the instrument, but the correct reading for the plumb staff can be taken in the following manner: At the direction of the leveller, who waves his hand slowly above his head as a signal, the staffman slowly waves or dips the staff backwards and forwards in the direction of the line of sight, and the leveller takes the smallest reading of the staff as the correct reading.

OPERATIONS OF LEVELLING

103. Example in Direct Levelling.—The general principles and methods of direct levelling are shown in Fig. 36. Let *A* be the starting point, the elevation of which is either known or assumed

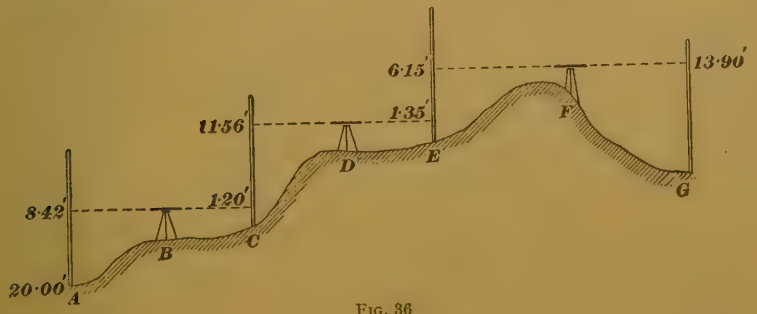


Fig. 36

to be 20 feet. The instrument is set up at *B*, levelled, and the staff, which is held at *A*, is sighted and the reading 8·42 feet taken. This sight, being directed back toward the starting point, is called a *backsight*. The reading 8·42 feet is the distance

of the line of sight above the point *A* as measured by the staff. The instrument is then turned in the opposite direction and another point *C* is chosen which must be below the line of sight. In the example this point is a *changing station*, or *turning point*, and the sight to it is a *foresight*. The staff is held at *C* and a sight taken to it, the reading being 1·20 feet; that is, as measured by the staff, the point *C* is 1·20 feet below the line of sight. The point *A* was found to be 8·42 feet below the line of sight, and therefore the point *C* is 8·42 − 1·20 = 7·22 feet above the point *A*. Since the height of *A* is assumed to be 20 feet above datum, the point *C* will be 20 + 7·22 = 27·22 feet above datum.

104. The instrument is now moved forwards to *D*, where it is set up and levelled. A backsight is taken to the staff still held at *C*, but turned round to face the instrument. The reading is found to be 11·56 feet. The staff is then taken to *E* and sighted, the reading being 1·35 feet. The point *E* is therefore 11·56 − 1·35 = 10·21 feet above the point *C*. The point *C* was found to be 27·22 feet above datum, therefore *E* is 27·22 + 10·21 = 37·43 feet above datum. The level is carried forwards and set up at *F* and a backsight taken to *E*, reading 6·15 feet. The staff is then taken to *G* and sighted and the reading 13·90 feet obtained. As the foresight, in this case, is greater than the backsight, the point *G* is lower in elevation than the point *E*, the amount being the difference of the two readings as before: 13·90 − 6·15 = 7·75 feet. The elevation of *E* is 37·43 feet above datum, and the elevation of *G* is therefore 37·43 − 7·75 = 29·68 feet above datum, or 9·68 feet higher than the starting point *A*.

105. **Levelling by Height of Instrument.**—A variation in the direct-levelling method which is sometimes adopted is that of calculating the height of the line of sight. This height is known as the **height of instrument**, and is obtained by adding the backsight to any point to the height of that point above datum. For instance, in the example given in Fig. 36, the reading of the staff, 8·42 feet, is the distance of the line of sight above *A*. If this is added to the elevation of point *A*, 20 feet, the height

of instrument is given. Thus, for the first setting of the level, the height of instrument is $20 + 8{\cdot}42 = 28{\cdot}42$ feet above datum. This is usually designated in the notes by the letters H.I. The elevation of point C is determined by subtracting the foresight from the height of instrument. Thus, $28{\cdot}42 - 1{\cdot}20 = 27{\cdot}22$ feet above datum. The next backsight, taken to point C from the new setting, is 11·56, and gives the height of instrument as $27{\cdot}22 + 11{\cdot}56 = 38{\cdot}78$ feet above datum.

106. Intermediate Sights. — The points A, C, E, G, the elevations of which with reference to the datum have been determined, may or may not be in a straight line, that is, in the same vertical plane; it will make no difference in the determination of their elevations. Such a series of elevations, however, is called a **line of levels.** It is evident that the elevations that can be determined by a line of levels need not be restricted to the turning points or changing stations to which both a foresight and a backsight are taken in each case. At each setting of the instrument, *intermediate sights* can be taken on any number of points for the purpose of determining their elevations, before taking a foresight on the turning point preparatory to moving the instrument. Points whose elevations are thus determined are called **intermediate sights.** The intermediate points on which staff readings are taken are usually the regular stations of the survey whose elevations are required, or, if the ground is very irregular, different points along the chain line between the stations. In small surveys, very often the level can be set up in the centre of the site and all the readings necessary can be taken without moving the level, so that there will only be one backsight and one foresight.

107. Lengths of Sights.—The most advantageous lengths of sights will depend on the optical properties of the instrument, the character of the surface of the country, condition and temperature of the air, the sensitiveness of the level bubble, and the degree of accuracy required. In the interest of accuracy, it is always best to have the sights of moderate length, avoiding either extremely long or short sights. For reasonably accurate work, the sights should not usually exceed about 200 feet, nor be less

than about 25 feet. Where the country is level and time is of great importance, while only an ordinary degree of accuracy is required, long sights may be taken, though little, if anything, is to be gained by taking sights longer than 400 feet. Where the surface rises or falls rapidly, short sights become necessary, but extremely short sights can always be avoided by setting the instrument to one side of the line or by following a somewhat zigzag course.

108. Bench Marks.—A permanent point whose elevation is determined in running a line of levels, and recorded for reference, is called a **bench mark.** In large surveys where there are not sufficient Ordnance bench marks, additional bench marks should be established at frequent intervals, from about 1,000 to 2,000 feet apart, depending on the character of the surface and the purpose for which the survey is made. Any well-defined and easily identified point on a permanent object, such as the door-step of a building, the projecting root of a tree, or a point on a large rock, will serve for a bench mark. Where trees are used, the point for the bench mark is cut on a projecting root. A tree with a large exposed root is chosen, the bench mark being cut on the root in the form of a pyramid, a tack driven into the apex, and the rod held on it. The tree is blazed smooth, and the letters B.M., together with the elevation of the bench mark, are written in the blaze with red chalk. A bench of this kind is shown in Fig. 37; the point *A* is the bench mark whose elevation is determined and written in the blaze at *B*. The elevation of each bench is recorded in the level notes, together with a sufficient description to identify it unmistakably. For this purpose and in the notes, the abbreviation B.M. is always used instead of the words bench mark.

FIG. 37

109. A bench mark which is placed by the Ordnance Survey Department, and whose height is given on the Ordnance map,

will always prove useful when levelling, and it is always advisable, where possible, to start at one of these bench marks and finish at another as a check to the levelling. Ordnance bench mark is usually abbreviated to O.B.M. When commencing an important survey, the Ordnance map should be looked at, and the nearest B.M. to the site should be found. The first level should be taken to the B.M. when commencing the survey, so that the levels on the plan may be those above Ordnance datum.

110. Check-Levels.—Before the elevations obtained by a line of levels are finally adopted as a basis for work or are plotted on the plans, their accuracy should be verified by a second line of levels over the most important and permanent points whose elevations were taken by the former line. Levels for this purpose are called **check-levels,** or **test levels.** In running check-levels, the most common practice is to take the elevations of bench marks, important and permanent points only, with, of course, such changing stations as may be necessary in order to cover the distance, but omitting nearly all the intermediate points or stations. Where variations of any considerable amount are found in the elevations as given by the two sets of levels, the levels should be run again over that portion of the line in which the variation occurs, in order to determine which of the former elevations is correct. Where the true elevation of a bench mark is found to differ from the elevation marked on it, the marking should be corrected. When running check-levels, the adjustments of the instrument should be tested frequently, and the staff-man should carry a small level which can be applied to the staff to ensure its being plumb.

FORMS FOR LEVEL NOTES

111. There are different forms in which level notes may be kept, but the method shown in Fig. 38 is a very good one. This form shows a series of levels, taken over known points on a site, which have been marked on the survey plan by numbers 1, 2, 3, etc. The backsights, intermediate sights, and foresights are booked in their respective columns, and the rise or fall is calculated in each case from the immediately preceding reading.

Thus, the backsight of 4·90 feet and the intermediate sight of 3·57 feet give a rise of 1·33 feet, since the second reading is smaller than the first. The intermediate sight 3·57 feet and the

LEVEL NOTES

Back-sight	Inter-mediate	Fore-sight	Rise	Fall	Height Above Datum	Mark	Distance	Remarks
					133·79	Sta. 1		
4·90					135·12	O.B.M.		Post Office
	3·57		1·33		130·73	Sta. 2	100	
	7·96			4·39	133·48	Sta. 3	200	
	5·21		2·75		134·77	Sta. 4	250	
	3·92		1·29		135·69	Sta. 5	275	
	3·00		·92		137·37	Sta. 6	350	
	1·32		1·68		136·55	Sta. 6A	400	Changing Sta.
		2·14		·82	136·55			
4·55					139·12	Sta. 7	450	
	1·98		2·57		139·12	Sta. 8	475	
	1·98				136·84	Sta. 9	500	
	4·26			2·28	138·99	Sta. 10		Changing Sta.
		2·11	2·15		138·99			
1·99					139·03	Sta. 12		
	1·95		·04		136·29	Sta. 13		
	4·69			2·74	136·05	Sta. 14		
	4·93			·24	138·70	Sta. 14A		
	2·28		2·65		137·13	Sta. 11		
	3·85			1·57	138·99			Changing Sta.
		1·99	1·86		138·99			
12·08					144·84	Sta. 15		
	6·23		5·85		146·77			Changing Sta.
		4·30	1·93		146·77			
5·45					144·77	Sta. 16		
	7·45			2·00	149·19	Sta. 17		Changing Sta.
		3·03	4·42		149·19			
2·06					144·69	Sta. 18		
	6·56			4·50	148·68	Sta. 20		Mark 19 removed
	2·57		3·99		144·95	Sta. 21		
	6·30			3·73	143·12			Changing Sta.
		8·13		1·83	143·12			
2·38					143·02	Sta. 22		
	2·48			·10	143·94	Sta. 23		
	1·56		·92		142·26	Sta. 24		
	3·24			1·68	135·54			Changing Sta.
		9·96		6·72	135·54			
3·33					133·80	Sta. 1		
		5·07		1·74				
36·74		36·73	34·35	34·34				
36·73			34·34					
·01			·01 = Error in closing					

FIG. 33

next intermediate sight 7·96 feet give a fall of 4·39 feet, since the second reading is greater than the first, and so on.

For the foresight 2·14 feet the rise or fall is calculated from the last intermediate sight, namely, 1·32 feet, which gives a fall of ·82 foot. The method of calculation is continued throughout, and at the end the foresights and backsights are added separately, the rises and falls are also added, and, if the values have been found correctly, the difference between the totals of the foresights and backsights will equal the difference between the totals of the rises and falls. The total of the backsights will be greater than the total of the foresights where the total rise is greater than the total fall, and vice versa. In this example an error of ·01 feet exists, but this is so small it can be ignored.

112. When the plotting of the survey drawing is completed, it is usual to put on it the levels above datum of the various points taken. These can be obtained from the level notes after they have been worked out ; under the column Height Above Datum. A circle is drawn on the drawing at the point at which the level was taken and the height above datum is inserted in figures within the circle. The points of the compass should always be put on the survey plan ; their direction can be obtained from the Ordnance map.

113. Another method of keeping the levels obtained in the field is to plot sections of the land along the lines on which the levels were taken. This is done from the level book containing the level notes. It is used to establish a gradient line showing the relative rises and falls of the land on the line taken. In engineering work, and sometimes in surveyors' work, a section shows all changes in elevation in an exaggerated manner by using a small scale for horizontal distances as compared with the scale used for vertical distances. It is convenient to use a horizontal scale of 100 feet to the inch and a vertical scale of 10 feet to the inch. When an architect is preparing the working drawings for a building, the levels of the site are generally set up as sections, using the same scale for vertical and horizontal distances, so that the levels may be incorporated with the working drawings.

114. Drawing the Section.—In Fig. 39 is shown a section drawn from the level notes given in Fig. 38 to a scale of 100 feet to the inch for horizontal and a scale of 10 feet to the inch for vertical distances. In Fig. 38 the distances have only been filled in for part of the survey, so that the section

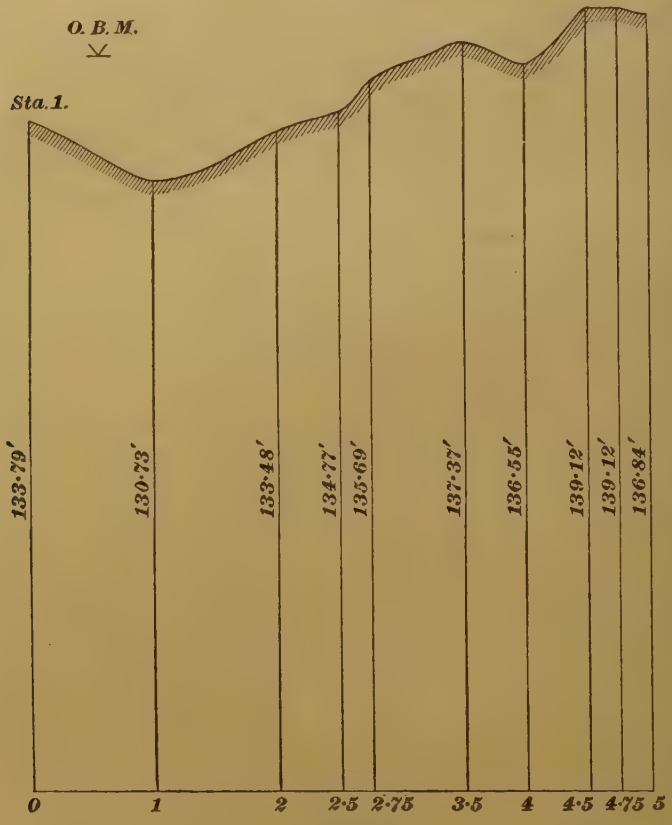


FIG. 39

shown in Fig. 39 might be worked out; in practice, the whole of the distances between each station would be filled in.

115. First draw a line at the bottom of the paper to represent the datum line; then, starting near the left-hand end of this line, set off to the scale of 100 feet to 1 inch the distances given in the Distance column. Then, from the zero point on the

datum line, set up vertically and to the vertical scale of 10 feet to 1 inch the first elevation, 133·79 feet. This fixes Sta. 1. The Ordnance bench mark can be shown on the section if it is desired to do so; but its real value is in the working out of Fig. 38, so that the various heights may be determined above a certain fixed datum, in this case the Ordnance datum as marked by the O.B.M.

116. Now set off verticals from the other distance points marked on the datum line drawn in Fig. 39, and on these verticals mark off the heights shown in the column Height Above Datum. At Sta. 2 the height above datum is 130·73 feet, and at Sta. 3, 133·48 feet. When these points are set out on the drawing a line can be drawn through them as shown, which line will be the outline of the level of the land or site on the particular line of levels taken to an exaggerated scale. If the distances were given for all the levels shown in Fig. 38, the levels would be worked out in a similar manner.

BUILDING SUPERINTENDENCE

(PART 2)

SYSTEM OF SUPERVISION

INFLUENCE OF SIZE OF WORK

ARCHITECT AND CLERK OF WORKS

1. Importance of Supervision.—The supervision of building work is one of the most important duties which must be carried out by an architect. No matter how well a building may be designed, it will not be satisfactory when completed unless it receives the constant attention of the architect or his representative during its erection, in order that the drawings shall in every respect be properly complied with, that any questions which may arise during the progress of the work shall be settled without causing any delay in the carrying out of the work, and that the materials used shall be in accordance with the specification. Probably the most difficult part of an architect's duties in this supervision is in obtaining proper compliance with the specification, yet this duty must be carried out in a thorough manner. Any laxity in enforcing the requirements of the specification is a breach of trust on the part of the architect, for it will usually result in the building owner receiving materials and workmanship of a lower standard than those for which he pays.

2. Means of Securing Supervision.—As it is impossible for an architect to spend all or even the greater part of his time on a building, it is usually considered, in the case of a small building,

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as, for instance, an ordinary suburban house, that such supervision as the architect can give while attending to his other work will meet the circumstances. In such a case, the architect pays periodic visits to the building every day or two, according to the rate of progress of the work. Supervision of this nature is not very effective if the contractor is dishonest, but this arrangement is justified by the fact that the cost of having a representative of the architect on a small building during the whole time of its erection will amount to a greater sum than any loss which the building owner may possibly sustain by the provision of inferior materials or workmanship in the building without the knowledge of the architect. In the case of all important buildings, however, a **clerk of works** is appointed. He spends all his time on the building, keeping the same hours as the workmen, and acts as the architect's representative. It is his duty to see that the work and materials are, in all respects, according to the drawings and specification. On works of a very large size, two or more clerks of works are sometimes employed, one, of course, having general control.

3. Appointment of Clerk of Works.—The clerk of works is paid by the owner, but, as the architect acts as the owner's representative in respect of all matters affecting the erection of the building, the clerk of works is under his control and is selected by him. Occasionally, men trained as architectural assistants undertake for a year or so the duties of clerk of works, but usually a clerk of works is a man who has passed through one of the building trades, and afterwards held the position of foreman, and has in other respects shown himself to be possessed of a good knowledge of the building trades, ability to understand architectural drawings, and general attainments above those of the ordinary artizan. He should be paid a reasonably good salary, so as to raise him above the many temptations that are liable to beset him in the proper carrying out of his duties. The salary paid to a good clerk of works varies from $2\frac{1}{2}$ to 4 guineas or more a week. Great care should be exercised in the selection of the clerk of works, for in the erection of a building much depends on his ability and honesty.

DUTIES OF SUPERVISION AND SUPERINTENDENCE

DUTIES OF ARCHITECT

4. Responsibility of Architect.—Though a clerk of works is employed, the architect retains sole responsibility for the erection of the building, and if, on its completion, serious defects are found which are obviously due to negligence in supervising the work, the architect will, in all probability, be required to pay damages if his client institutes legal proceedings against him. Evidence that the clerk of works was incompetent or untrustworthy will be of no avail if the architect is unable to prove that he himself exercised such supervision as was possible, without spending an undue proportion of his time on the works.

5. Architect's Relations With Owner.—The architect should remember that primarily he is working for the owner's interests, and should therefore not be led into making any concessions to the contractor that will be injurious to the owner. At the same time he should be perfectly just and reasonable in passing any of the work or material or in deciding a disputed point. In those cases where it is provided in the contract that he shall act as arbitrator, he, of course, must consider the interests of both parties, and give his decision in an entirely impartial manner.

6. Interpretation of Specifications.—The architect's tact and good judgment will often be in demand when settling disputes as regards the interpretation of such phrases in the specification as "in a good and substantial manner," or "in a workmanlike manner." In these cases, while being just, he should lean more toward severity than toward leniency, as liberality is usually taken advantage of. The architect, however, should not use these general phrases in writing a specification if they can satisfactorily be avoided, but should substitute for them exact language that cannot be misunderstood. The loose method of writing specifications is unfortunately, however, very common.

7. Subcontractors.—It is practically unavoidable to employ subcontractors, for such works as steel construction, carving, electric lighting, and copper and zinc work are almost invariably carried out by subcontracts. In all cases where subcontractors are employed, the general contractor should be made responsible for the whole of the work. It is a well-known fact that work divided among a number of men on the same job is seldom completed without serious debates arising as to who should do certain pieces of work, or, if done wrongly, who is guilty ; in short, one will shift the responsibility on to another in the effort to save himself. The best plan, therefore, is that of giving the entire work to one man and making him directly responsible to the owner for every part of it, including the work of all special tradesmen, whether these may have been chosen by the architect or the contractor. Then, in the event of mistakes, bad work, or the like, there is only one man to look to for its correction. It is usual to provide in the specification that the contractor shall allow for attending on, cutting away for, and making good after, all trades.

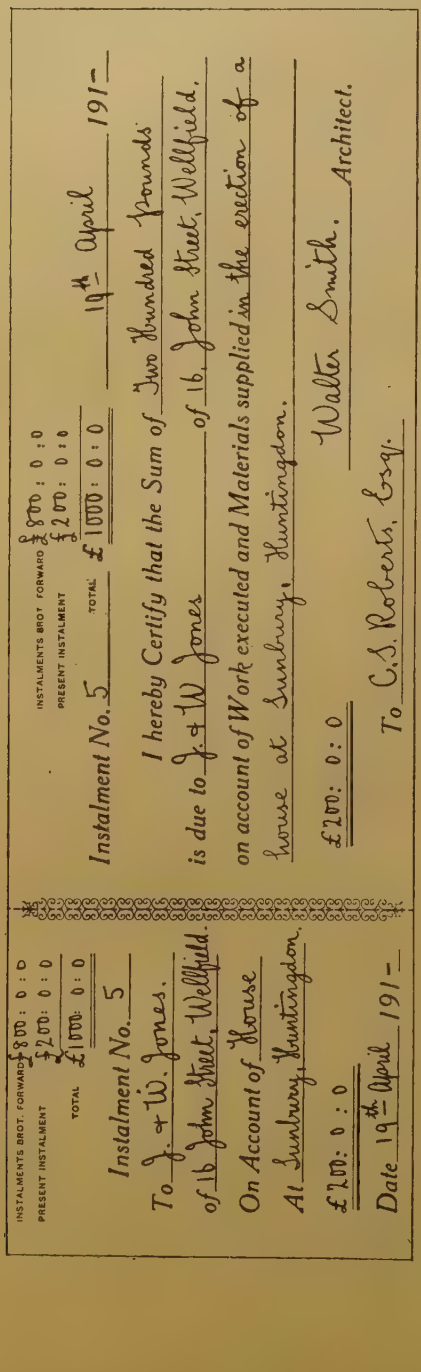
8. Condemning Work.—The architect should never attempt to obtain the rectification of unsatisfactory work of subcontractors except through the general contractor. Should their work be unsatisfactory, the architect should notify the general contractor in writing to make the necessary alterations. If the notice is not complied with within a reasonable time the general contractor should be served with a second written notice, and if he should then refuse or neglect to make the change within a specified time, the usual contract empowers the owner to have the work executed by another person and to deduct the cost from the amount afterwards to be paid to the general contractor, through whom all payments to subcontractors should always be made.

9. Notices and Orders.—The architect should make it a rule when notifying the contractor relative to imperfect work, material, delays, and the like, to write all communications and retain a copy of each letter. These copies serve as a record of orders and notices given, and reduce the possibility of misunderstanding and

dispute as to whether certain work or material was or was not condemned, the date when it was condemned, etc. Very frequently, when visiting the building while in course of construction, the owner discovers some material or construction that is not in accordance with his preconceived idea, and he may be so unbusinesslike and inconsiderate of the architect's position as at once to order the contractor to make certain changes that may involve more or less work and material. Instead of doing this, the owner should consult the architect, who will issue a written order to the contractor for any particular change and instruct the clerk of works to make a record of the work omitted or extra work done, as the case may be. This compels the orders to follow the proper channels and provides the usual records of the entire transaction; moreover, the owner is better protected by this requirement against overcharge and against omissions of credits due to him for work that may be left out.

10. Alterations or Delays.—Should any alterations in the work be required, or should it become necessary to press forward the execution of some particular part of the work, a letter to that effect sent to the general contractor is usually sufficient. In case of non-compliance, a remedy similar to that given for faulty work should be provided by the contract. Where the contractor is not a good business man vexatious delays are liable to occur; but in ordinary cases, when a reasonable time is allowed for the execution of the work, it will be to the contractor's interest to push the work forwards with all convenient speed.

11. Records of Condition of Work.—As an architect should be in a position, both during the erection and after the completion of a building, to state what was the condition of the work at any particular time, careful records should be kept of the progress of the work. The clerk of works should be required to send to him a weekly report that will give full details of the state of the work. Also, the architect should make a note in his diary on the occasion of each visit of the condition of the work, any special matters which attracted his attention, and any work which was unsatisfactory, and was thus required by him to be amended by the contractor. The architect in making such notes should bear



INSTALMENTS BROT. FORWARD £800 : 0 : 0
PRESENT INSTALMENT £200 : 0 : 0
TOTAL £1000 : 0 : 0

Instalment No. 5

To J. & W. Jones.
of 16 John Street, Wellfield.
On Account of House
At Sunbury, Huntingdon.
£200 : 0 : 0
Date 19th April 191-

INSTALMENTS BROT FORWARD £800 : 0 : 0
PRESENT INSTALMENT £200 : 0 : 0
TOTAL £1000 : 0 : 0

Instalment No. 5 *19th April 191-*

I hereby Certify that the Sum of Two Hundred Pounds
is due to J. & W. Jones of 16, John Street, Wellfield,
on account of Work executed and Materials supplied in the erection of a
house at Sunbury, Huntingdon.
£200 : 0 : 0

Walter Smith. Architect.

To C.S. Roberts, Esq.

FIG. 1

in mind the fact that, in the event of a dispute arising, it may be necessary to produce his diary in a court of law.

12. Architect's Certificate.—It is usually stated in the contract that payments are to be made to the contractor on the **architect's certificate** being from time to time given to the effect that the value of the work has reached a certain specified sum. The architect must therefore make out a certificate to the owner when the contractor is entitled to an instalment. The architect, however, does not certify payment for the full value of the work, but for a certain percentage, in accordance with the arrangement specified in the contract. Architects in issuing their certificates usually employ a special form, a book of which may be obtained from any stationer. In Fig. 1 is shown a page from such a book, filled in as would be the case in practice. The

right-hand portion of the page, when filled in, is torn off and sent to the builder ; the left-hand portion remains as a counterfoil in the book and constitutes the architect's record. There are spaces at the top of the form for the insertion of the amount of past instalments, the instalment in respect of which the certificate is issued, and the total sum covered by certificates. If these items are correctly entered, the architect is able to see at a glance the total amount certified in respect of a building by referring to the last counterfoil in his certificate book which has reference to such building.

DUTIES OF CLERK OF WORKS

13. Compliance With Architect's Directions.—The clerk of works is the architect's representative on the works, and must in every respect conform to the directions of the architect. As a rule, the architect allows the clerk of works a fair amount of discretion in dealing with matters of detail, but at the commencement of the work, if the architect is not acquainted with the clerk of works, he usually desires to be kept informed of every detailed point decided by him. Then, after a time, if he finds that the clerk of works is carrying out his duties in a thoroughly satisfactory manner, he will be willing to leave all minor questions to be dealt with by him entirely at his own discretion, and will require to be kept informed only of questions in which main points of construction are concerned. A good clerk of works will not take advantage of the trust placed in him, and, while saving the architect from being bothered by simple matters of detail, will refer all important matters to him for his decision.

14. Order for Material.—The clerk of works should never order any material or furnish measurements to subcontractors, otherwise he will place himself in the position of the contractor's agent and thus jeopardize the owner's interest. The contractor himself should always set out the work, take all necessary measurements, and order all material. Where measures of shoring or underpinning to existing work are required, the

contractor, unless it is otherwise stated in the specification, is solely responsible for the proper carrying out of such measures. Consequently he is entitled to adopt such detailed arrangements of construction as he may think fit, and the clerk of works should not interfere in the matter.

15. System of Supervision.—It is difficult to formulate rules to be observed in the superintendence of building work that will be applicable to all cases. Each problem of construction must be considered separately, and a system of inspection should be decided on to suit each particular portion of the work. It is necessary, however, to lay down a fixed plan to follow in superintending, in order to draw attention to the innumerable points in construction that require immediate attention. If improper work is once finished it is not always easily changed, and, if ordered to be changed or replaced by other work, will generally cause disputes and dissatisfaction, and may often cause expensive alterations, all of which could have been obviated by attending to the defects or mistakes at the proper time. A good clerk of works will think out the most suitable system to be adopted in supervising any work of which he is put in charge.

16. Drawings.—Although it is a common custom to send drawings direct to the general contractor, many architects think it desirable that all drawings should be sent in the first instance to the clerk of works to be passed on by him, with the exception of a copy of each, which he will retain for his own use. This arrangement enables the clerk of works to be fully conversant with every detail of the work that is to be executed by the contractor, and ensures that there is a proper check on the drawings received at the works. The clerk of works should carefully study the drawings and specification, in order to become as familiar with them as possible and to form a thorough understanding of the projected building, its surroundings, and the materials that are to be used in its construction. As, however, no matter how carefully drawings are prepared, inaccuracies sometimes occur, when familiarizing himself with the drawings the clerk of works should compare carefully with one another

the plans, elevations, and sections. Not infrequently the figured dimensions on the plans do not agree with those on the sections or elevations, which it is very important should be discovered before the setting out of the building is commenced. The architect is then able to decide as to which dimension shall be followed without his decision being fettered by the fact that the work is already set out.

17. Inspection.—It is imperative that the clerk of works should inspect each item of the work day by day. He should ascertain what each workman is doing and should see that it is being done properly, and on his next visit over the building he should find out whether the work in progress at the time of the previous visit has been acceptably done. By following up the work in this way, it will be, comparatively speaking, an easy matter to detect any poor or improper work. The clerk of works should endeavour to establish a standard by which each kind of work may be judged, that is, a uniform standard of practice in executing the work, so that the builder will be in no uncertainty as to what class of work will be accepted. If the clerk of works finds that a workman is incompetent, he should inform the architect accordingly. The latter can then decide whether to exercise the power usually given him by the contract, and require the dismissal of the incompetent workman.

18. Materials.—It is a good practice to examine and pass all materials as soon as possible after they arrive on the building site. If any obviously defective materials are discovered, they should be at once rejected. No materials which are of a doubtful character should be allowed to be used until the architect has seen and accepted them. The clerk of works should see that damaged or rejected materials are immediately removed from the premises. If the clerk of works is satisfied that a certain batch of concrete contains poor or reworked material, he should order the removal of both improper work and material at once and see that his orders are carried out. He should not trust to the statements of the workmen, who very often, rather than replace the work, will try to convince him that the material is mixed as required by the specification, and is freshly made.

WALTER SMITH, ARCHITECT,
50, GRAY'S INN SQUARE, LONDON, W.C.

No. 12

WEEKLY REPORT of the State of Works, from Saturday, 24th May to Saturday, 31st May 191-

Trade.	No. of Men.	Works proceeding upon	Height of Building in progress above ground floor.	Drawings required and remarks.
Foreman	1	General brickwork		
Watchman	1	slating to back	Back addition	Joinery details for
General Labourers	5	roofs just	complete except	cupboards in bedrooms
Masons	1	commenced.	slating. Front	and finishings to fireplace
Setters	–	stoves sills and	portion brickwork	ingle nook in Dining Room,
Bricklayers	6	steps being	up to top of first	Plaster cornice details
Carpenters	4	bedded. Iron	floor window	
Joiners	–	railings to	heads.	
Slaters	2	back area being		
Plasterers	–	fixed		
Smiths	1			
Fitters				
Plumbers and Mates	2			
Painters	–			
Glaziers	–			
Engine Drivers ...	–			
Fireproof Constructors	–			
TOTAL ...	23			

DAY WORK.

Trades.	Hours.	Materials.	Description of Work.	Tradesmen for provisional sums, &c.
				Lead glazier called to take sizes.
				Electrician called to see if work was sufficiently forward for him to commence his work. Found it was not.

STATE OF THE WEATHER

Monday ...	Fine	Thursday ...	Rain 3 hrs.
Tuesday ...	Fine	Friday ...	Dull
Wednesday ...	Fine	Saturday ...	Fine

(Signed) A R Crompton
Clerk of Works.
31st May 191-

FIG. 2

19. Sometimes, when a particular brand of some material, such as cement, is specified, the contractor, for reasons of his own, may say that the brand cannot be obtained in the local market, and that, in order to get it, the work must be delayed, and then, as a substitute, offer another brand. In such a case, the clerk of works should ascertain for himself whether the brand specified can be obtained without delay; if it cannot, he should satisfy himself as to whether or not the suggested substitute is as good as that specified, and should report to the architect accordingly, and await his instructions. If the architect knows what materials can be had in the local market and prepares his specification accordingly, or if ample time is given for ordering materials that cannot be obtained in the local market, no such questions as the foregoing should arise.

20. Clerk of Works' Records.—Each day the clerk of works makes exact memoranda of regular and extra work done, the number of workmen at work, the state of the weather, drawings on hand and drawings required, and any other information that may be of service to the architect. These records are usually made on a printed form prepared for that purpose, and should not cover more than 1 week's time. They are delivered to the architect at the end of each week, and are filed in his office, where they may be referred to at any time to enlighten him as to the progress of the work, drawings furnished or needed, and other matters of importance. An example of a printed report form is given in Fig. 2. This is filled in by the clerk of works for a fair-sized building. The columns for day work are not filled in, for there has been no work of this description in progress when the report was made out. Day work should be avoided as much as possible, for work that is not carried out for a definite contract sum is always expensive.

21. Office for Clerk of Works.—An office should always be provided for the clerk of works, in which he should keep copies of all drawings used during the progress of the work. This office should be well lighted and should contain a table or desk on which the drawings may be spread. Since the clerk of works may occasionally be required to make a drawing, this desk should

be fitted like one used in an architect's office, and with a drawer or two. Where there are apt to be many drawings, a set of drawers should be provided, so that the drawings may be kept according to some system. One good system is the placing of all small-scale drawings in one drawer, all larger detail drawings in another drawer, all full-size detail drawings in a third, etc. In the case of large buildings, a telephone is often installed in the clerk of works' office, as the larger the building the more numerous are the points in respect of which the architect's decision is required.

PRACTICAL SUPERINTENDENCE

PRELIMINARY OPERATIONS

SETTING OUT WORK

22. The method of superintending is dealt with in this Section on general principles only; these principles will apply to practically any buildings that may be erected. Although a clerk of works is not usually employed on a building like that for which the drawings are shown in *Architectural Drawing*, it is always advisable to have one whenever the employer will agree to the extra cost involved in the payment of his salary.

When a clerk of works is not employed, the architect should visit the works more frequently, and should look out for the many points, at the time of his visits, that a clerk of works would deal with if he were on the building. Although the supervision of the work cannot be so thorough when a clerk of works is not employed, a great number of comparatively small works are carried through without one. If the house is being erected from the drawings contained in *Architectural Drawing*, and a clerk of works is employed, the method of superintending its erection will follow the general principles set out in this Section, although in every different building special difficulties may arise which will need individual consideration. Some materials and methods of workmanship may be dealt with in this Section that are not

included in the drawings for the house in *Architectural Drawing*, but they have been inserted so that a good idea may be obtained of how they should be dealt with if they are used on another building the architect may have to erect. It is assumed that the working drawings have been made, that the survey of the site has been made, that the levels have been taken, and that the position of the house on the site has been determined. The work will be considered in the order in which it is usually done, the common errors, imperfections, or omissions likely to be met with, and the best way of forestalling or detecting them, being pointed out.

23. The clerk of works is furnished with a copy of the survey, a full set of the drawings, and a copy of the specification, with which he should make himself familiar. The contractor has a copy of the contract drawings and specification, and also, generally, additional copies of the same for use on the works. The first matter requiring the contractor's attention is that of setting out the building. For this work he is solely responsible, and must rectify at his own cost any mistakes which may be made ; but the architect, or the clerk of works if there is one employed on the works, invariably checks the setting out. The checking is best done during the operation itself, and it is customary for the architect or clerk of works to arrange with the contractor to be present when the setting out takes place.

24. Principles of Setting Out Buildings.—Though the operation of setting out a large house or building is a long one, the principles involved can be well explained in connection with the comparatively small house here set out. If, in the erection of this house, the employer will not agree to the employment of a clerk of works, the setting out must be checked by the architect himself. The setting out of all buildings of ordinary size and shape is effected by means of right angles.

25. Setting Out a Right Angle.—The two common methods of setting out a right angle on the site are : (*a*) By the use of the *builder's square*, and (*b*) by the use of the tape or chain applied in accordance with the rule commonly known as the

3-4-5 rule. The builder's square consists of two stiff pieces of timber *a*, Fig. 3, placed very accurately at right angles to each other, and connected together by a halved joint at the angle and by a brace *b*, which is halved to them and is, preferably, inclined at an angle of 45°.

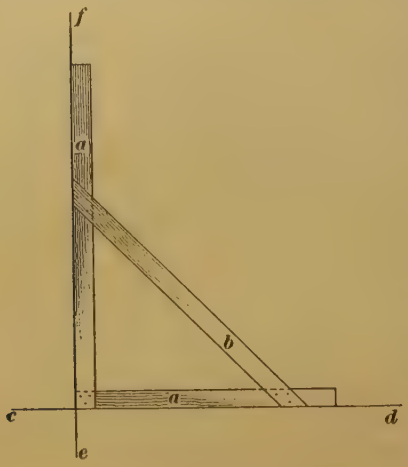


FIG. 3

To set out a right angle by means of this square, one side of the square is placed so that its edge exactly coincides with a bricklayer's line *c d* that is tightly stretched to form a base. A second bricklayer's line *e f* is stretched along the other side of the square, and is carried as far in the direction *f* as the required right-angled line, the position of which is thus obtained, is to be drawn. The greatest care should be taken to make the lines in both cases exactly coincide with the edges of the square.

26. Checking Accuracy of Square.—The sides of a builder's square should be exact multiples of 3 and 4. Lengths of, respectively, 6 and 8 feet are very convenient, for the square's accuracy may be roughly checked by means of a 10-foot rod, because the distance from corner to corner should equal 10 feet if the square is properly constructed. A more accurate method of testing a builder's square is to stretch two lines *c d*, *e f*, Fig. 3, so that they exactly coincide with the edges of the square. Then, should the square be turned over, with, as it were, the line *e f* for a pivot, if it is accurately formed, its edge will coincide with the line *c d* when produced the necessary distance in the direction *c*. If the edge of the square does not so coincide with this line, the square is inaccurate and it must be shaved down on one side by means of a plane. The actual inaccuracy is only one-half the apparent inaccuracy shown by the test; for, as the lines

formed by the sides of the square in each of its two positions show a departure from a true right angle, the difference between the two lines, which would have coincided if the square had been accurate, represents twice the actual error.

27. **Application of the 3-4-5 Rule.**—The **3-4-5 rule** is based on the fact that the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the other two sides. The square of 5 is equal to the sum of the squares of 4 and 3; this ratio also holds good in the case of all multiples of these figures. Right angles are more accurately set out by this method than by means of the builder's square.

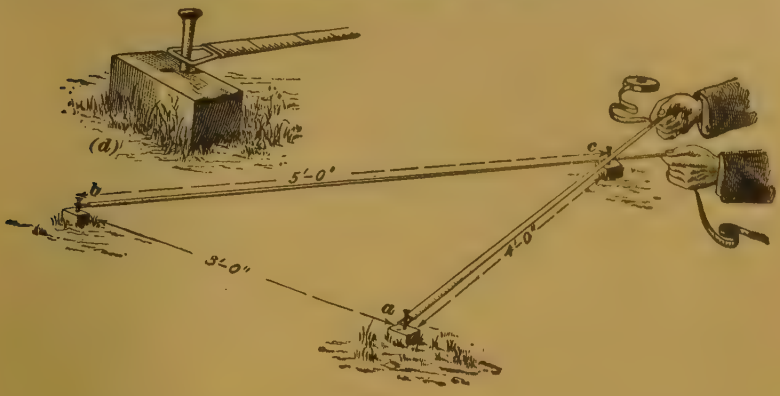


FIG. 4

To use this method, first measure off 3 feet from one end *a*, Fig. 4, of a base line which has been already established, and drive at this point a temporary peg *b*, in the top of which a tack is placed. Then drive nails into both pegs *a*, *b* alongside the tacks, as shown in (*d*), in such a position that when the ring of the tape is placed over the nail the end of the ring will be directly over the tacks, thus ensuring a correct measurement. The rings of two tapes are then placed over the nails at *a* and *b* and the tapes stretched toward *c* until the 4-foot point on *a c* intersects the 5-foot point on *b c*. This point of intersection being found, a peg is driven and a nail placed therein, as shown, thus determining the position of a line *a c* at right angles to the line *a b*, the angle *b a c* being a right angle. For practical work,

the lengths of 30, 40, and 50 feet, or some other multiples of 3, 4, and 5, should be adopted, as the longer the lines the less is the likelihood of error. Only steel tapes should be used, for great accuracy is not possible with linen tapes.

28. A right angle may be set out by means of a single surveyor's link chain. A base line *a b*, Fig. 4, of 30 feet or links, depending on the units into which the chain is divided, is set out as just described. One end of the chain is then fastened to one peg *a*, and the chain, at a point 90 feet or links distant from such end, is fixed or held over the nail which has been driven in the other peg *b*. Then, if the chain is held at 40 feet from the point *a* from which a right angle is to be set out and is stretched tight, a right angle will be formed similar to that shown in Fig. 4, with the difference that instead of the lines *b c* and *a c* being formed of two tapes they are formed by a single 90-foot or 90-link length of chain.

29. Method of Setting Out. — When commencing to set out the building, the contractor notes from the block plan that the distance of the north-east main wall of the building from the fence is 9 feet 3 inches and the distance of the main front wall from the roadway is 37 feet. All other data required in the setting out are obtained from the ground-floor plan. The contractor is assisted by two men, who carry a hatchet, a bundle of pegs, a plumb-bob, a few nails, and two 100-foot steel tapes. He has also had delivered on the site 30 pieces of studding with sharpened ends, each 4 or 5 feet long, and about one-half as many pieces of rough fir boarding from 5 to 8 feet long.

30. From the measurements on the block plan and ground-floor plan, the contractor determines the position, on the face line of the proposed fence wall next to the roadway, of the points *a*, *b*, *c*, *d*, and *e*, Fig. 5. These points are the projections of the lines marking the outer face of the dining-room fireplace, the north-east wall of the house, the wall of the projection in the dining-room, the wall of the projection in the rear of the house, and the south-west wall of the house, respectively. Then, having driven pegs at all these points, and

also a nail in each peg, by means of the 3-4-5 rule, the contractor sets off lines, in the direction of the house, at right angles to the line of pegs, as the frontage line of the house is parallel with the boundary line of the site. He then places pegs at points *8, 13; 7, 14; 6, 15; 5, 16,* and *3, 18* along these lines; these pegs are then at least 8 feet from the outside line of the rear and front walls. Pegs are then driven along the fence line next the roadway at points *1′, 4′, 17′, 12′,* 8 feet from points *e, d, c,* and *a,* respectively. The position of

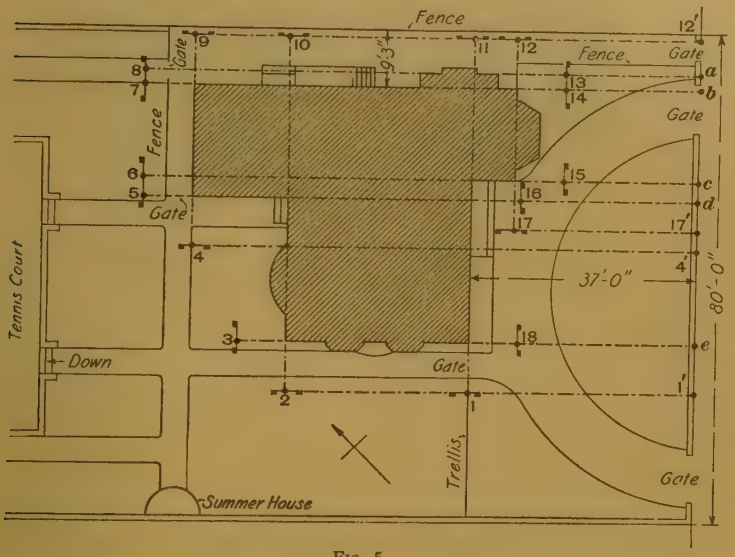


Fig. 5

points *1, 2, 4, 17, 9, 10, 11,* and *12* are then found on lines run at right angles to the fence line from the points *1′, 4′, 17′,* and *12′;* they mark the positions of the return-walls.

After all the pegs have been driven and the nails accurately placed, and the architect or clerk of works has given his approval, the contractor erects line boards, termed **profiles,** over the stakes, as shown in Fig. 6. By plumbing down to the nail in each stake, he then determines the position of, and with a notch and appropriate lettering marks on the boards, the lines for all the walls.

31. The lines obtained by this method are for the outside of walls only; those for the inside and for the excavation may be found by simply measuring along on the line board, as shown in Fig. 6. In the example shown in Fig. 6, the wall varies in thickness above and below the ground-floor line, and the lines determining both thicknesses are shown. The position of the inside lines is determined in the same way where it is impossible

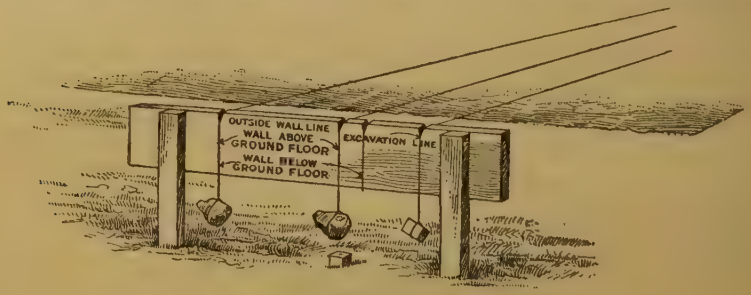


FIG. 6

to fix their position by means of the line boards. When the bricklayers begin work, lines will be stretched between the line boards and thus serve as guides.

Should the fence be at some distance from the house, it will be necessary to adopt a line nearer the house on which to set off the distances *a*, *b*, *c*, *d*, and *e*, Fig. 5. If the front of the house is not parallel with the fence, a line parallel to the front of the house must, of course, be taken as the basis of the setting out.

32. Incorrect Method.—Sometimes, when setting out, the pegs are inserted to mark the outline of the building, and then, as these would obviously be in the way of the building operations, other pegs are driven in line with these in such positions as not to be affected by the carrying out of the work, and the original pegs removed. But this method involves unnecessary work, as the pegs marking the outline of the building serve no useful purpose. It may be taken as a general rule throughout building operations, that although the setting out of work on a regular plan may take up time in the first instance, it will yet result in a saving of time in the end. The setting out of a building is no exception to this rule.

SUPERINTENDENCE OF EXCAVATION

33. Progress of Work.—After the setting out has been completed, the excavation first of the surface soil and then of the trenches for the foundations must be commenced. As the clerk of works has not very much to attend to at this stage, he should carefully examine all the drawings, check all the main dimensions, and memorize the plans and specification as thoroughly as possible. By this means he will become familiar with the structural parts of the work, and will be able to anticipate questions likely to be raised by the contractor. All points of construction that may not have seemed to him to have been shown very clearly on the drawings should be brought to the attention of the architect, and his wishes in regard to the same learnt, so that a decision may be made without delay should any question arise in regard to the work.

34. Excavated Materials.—If the sod on the site of the building is of good quality, it is often stated in the specification that it shall be cut from the ground in strips 16 inches wide and from 4 to 6 feet long, and shall be rolled up and piled at the rear of the site for use in the formation of a tennis lawn. The top soil, loam, and gravel must then be placed in separate spoil banks, or heaps, away from the building and at a point that will be convenient when the material is wanted for making up the garden and tennis lawn to the required levels. The excavated materials should not be placed nearer the edge of the excavation than 8 feet, so as to allow room for the erection of scaffolding and a walking space on the outside. If the excavated material is more than sufficient to effect any necessary levelling and embanking on the site, the clerk of works should see that the surplus material is carted away by the contractor in accordance with the terms of the specification.

35. While the excavated materials should be placed at a point that will be as convenient as possible when they are wanted again, they should not be deposited in such a position as to be a hindrance to the work. For instance, the earth shovelled from the

excavation is often heaped up to a considerable height without any regard to the position of the exterior piers or trenches. This is very poor practice, for when these are to be excavated, this pile of soil, as well as the undisturbed earth beneath, must be dug out, thus involving the contractor in extra expense and loss of time that could have been prevented.

36. Excavation.—The duty of the clerk of works in superintending the excavation is merely to see that the trenches are carried to a sufficient depth to admit of the foundations being constructed at the depth shown on the drawings, and to see whether any unexpected difficulties are met with in obtaining a good bearing for the foundations. Any question of the strutting of the trenches must be decided by the contractor without the intervention of the clerk of works; the responsibility of all measures adopted in the carrying out of the work rests with the contractor. In this case the soil for 3 feet thick is composed of loam, and that below this consists of a stiff clay, and there is no tendency for the sides of the trenches to slide or crumble inwards. Nearly all soils, unless very dry, will retain their shapes for a time when cut to a vertical face unless disturbed or acted on by frost or moisture. The earth acted on in this way assumes its angle of repose, which varies according to the nature of the soil itself. In excavating earth to any great depth, or in any case when the excavations are to be left open for a long time, the bank should be held in place by means of strutting and planking, or the sides of the excavation should be cut to a slope of a steepness not exceeding 60°.

37. Hollow in the Clay.—From the trial holes dug previous to the preparation of the working drawings for the building it appeared that clay occurred at an average depth of 3 feet below the surface; therefore, the level of the foundations shown on the drawings was arranged to admit of the building resting on clay. In carrying out the work, however, it is found that for a length of about 10 feet along the line of one of the trenches the loam extends to a much greater depth than elsewhere and is of a less compact character. The clerk of works directs that no foundation work be carried out in this portion of the building

until the architect has seen the condition of affairs. The architect, on his arrival, directs that a portion of the excavation shall be extended downwards until clay is found to be situated, which is 8 feet below the surface. Further investigation shows that the depression is found to extend some distance on either side of the trench. It is consequently thought that the hollow has resulted from the removal of clay for local brickmaking many years ago, and that it has been since filled up with loam.

38. Choice of Construction.—As the foundation cannot be carried over this loose soil, either the concrete foundation must be strengthened by means of steel joists or bars, so as to enable it to carry the wall safely, or the wall must be carried down to the clay. The architect directs that the latter shall be done and that the brickwork, up to the level at which the brickwork of the rest of the wall commences, shall be built in cement. This is the better arrangement, although the other would probably have been the cheaper.

The reason why the portion of the wall which is carried to a lower level than the rest is to be built in cement is that, if it were built in lime mortar, the joints might contract slightly during the course of setting, in which case cracks would occur at the junction with the general walling. The work necessitated by this unanticipated hollow in the clay must form an extra on the contract, and the extent of the extra excavation necessitated, and extra brickwork used, must be carefully measured by the clerk of works and the particulars forwarded to the architect.

39. Excavation Affected by Springs.—As the clay on the site of the building considered is very near the surface, and is surmounted by loam, no springs are anticipated or found. In a site, however, where the clay is at a considerable distance below the surface and is surmounted by a layer of gravel or gravel and sand, springs often occur. If the soil is gravel and the foundation rests on the gravel, the depth of the excavation will not usually be such as to reach the level of the springs. But where the soil is gravel and sand subject to the action of water, and thus not very dependable, as the sand in the gravel is liable to be

washed away, it will usually be desirable to carry the foundation down to the clay, in which case springs may be encountered. Any spring that is met with should be diverted in order that the foundation may, as far as possible, be kept dry. This may be done by providing earthenware field pipes with butt joints, or by excavating a trench, sometimes called a *French drain*, filled with broken stone or brick. The line of pipes or drain should be run to a pit filled with large stones at a point where the water may become distributed in the surrounding soil without affecting the foundations of the building.

CONSTRUCTION OF WALLS

INSPECTION OF FOUNDATION AND WALLING MATERIALS

40. Arrival of Materials on Site.—While the excavation is proceeding, materials are each day arriving on the site. They should be placed in such a position as to be readily available for use in the construction, and at the same time they should not interfere with the proper carrying out of the building operations. A shed for the storage of lime and cement should be erected. As the materials arrive the clerk of works should carefully inspect them and reject any which do not conform to the specification. He also should pay very careful attention to the preparation and mixing of the mortar and concrete.

41. Inspection of Sand.—The clerk of works, in examining the sand, should see that, after it is compressed in the hand, it does not cake nor cling together, thus indicating that it contains very little loam, or, in a word, is *clean*. Neither should it discolour the hands, which is another test for the presence of loam ; he may further examine its quality with a microscope, which will reveal the relative amounts of sand and loam, if any. Should the sand be found to contain loam to any appreciable extent it should be condemned, for the presence of loam prevents the proper setting of the lime or cement to which the sand is added. Such sand may, however, be used if it is properly

washed by the contractor. Coarse sand is preferable to an exceedingly fine sand, and sand obtained from quartz sand pits or crushed-granite screenings from a stone crusher constitute the best quality. The coarser grades of sand are used for rough stonework or common brickwork, while the finer sand is used for pressed brick and ashlar. Very coarse sand should be screened to remove the coarser particles when the sand is to be used for forming mortar.

42. Inspection of Aggregate for Concrete.—There is a tendency to pay too little attention to the character of the material used to form the aggregate of a concrete. As, however, the strength of a concrete is the strength of its weakest constituent, it will be of little value to pay great attention to the matrix if no trouble is taken to ensure an equally good aggregate. An architect, therefore, should instruct his clerk of works carefully to watch the material used as an aggregate in the concrete, and to reject it if it does not conform to the specification. The characteristic of hardness is invariably required, and the maximum size of the particles of the aggregate is often specified. Care should be taken that the broken stone has not been so crushed in the breaking as to have lost its strength. It is most desirable for the particles to be of varying sizes, so that they will interlock with one another. Hard broken brick is often used as an aggregate, and when mixed with rounded shingle is considered to improve the quality of the aggregate, which otherwise is not sufficiently rough to form a good hold for the cement.

43. Inspection of Lime.—The lime used on ordinary building works is fat lime for plastering, and some more or less hydraulic lime, such as greystone lime, or lias lime for walling. Lime is supplied either in the lump or ground. Some persons prefer lump lime, for the reason that defects are more easily noticed when the lime is supplied in this form. If, when examined, most of the lime is found to have crumbled, the lime has become air-slaked. If a few lumps taken at random do not slake when immersed in water, the lime must be condemned as unfit for use and the contractor required to remove it from the works. If, when a few lumps of lime are immersed in water, two or

three of them begin to slake immediately, but the others remain inert for some time and then slake slowly, leaving a hard centre, or core, the lime is underburnt and should be condemned and removed from the works. Lime of this kind, if mixed in the mortar, will slake slowly and swell, thereby causing the mortar to crack. Overburnt lime is even worse than underburnt, for the lumps, being hard, resist the action of the water and do not slake readily, the slaking process commencing slowly and a great deal of time being consumed in the process. Any lime that is overburnt should be rejected.

When a few lumps of first-class lime are immersed in water, the slaking process will commence almost immediately. The action, due to the oxygen of the water combining with the lime in slaking, gives forth a hissing sound, and a warm white vapour arises, resulting in a creamy unctuous mixture with no residue. When this occurs a lime is known to be satisfactory.

44. If it is desired to learn the hydraulic properties of some particular make of lime, and thus ascertain whether this lime is hydraulic and suitable for use in damp situations or under water, the following test should be sufficient under ordinary circumstances: Immerse in water a cake formed of a stiff mortar mixed in the proportion of 1 part of lime paste to 2 parts of clean sharp sand, thoroughly incorporated by continual working until all streaks disappear. If, after at least 24 hours, the cake has hardened perceptibly, the lime may be reasonably inferred to be hydraulic.

45. Inspection and Testing of Portland Cement.—In engineering works, very large architectural work, and where reinforced concrete is used, the Portland cement must generally be in accordance with the standard specification of the Engineering Standards Committee. This specification contains a list of required tests, but some of them can be applied only when special apparatus is available. These tests are too stringent and comprehensive for ordinary building operations. For this work it is customary to specify the fineness of grinding by stating that no greater proportion than 5 or 10 per cent. of the cement shall be retained on a sieve having a stated number of meshes

to the square inch. Until quite recently, it was thought sufficient to specify a sieve having 2,500 meshes to the square inch for this test, but much finer sieves are now often specified. An ultimate tensile strength, varying from 350 to 450 pounds per square inch after 7 days, is usually specified, together with, in some cases, the maximum and minimum times within which the cement must set. A competent clerk of works should experience no difficulty in applying all these tests. The old method of requiring the cement to weigh a certain amount per striked bushel has been superseded by a requirement that the specific gravity shall not be less than a certain figure, usually 3·1. The testing of the specific gravity is generally carried out by a properly qualified chemist. All these requirements have their value, but probably the most important requirement in an ordinary architectural specification is that the cement shall be that of a specified firm of makers.

46. A clerk of works is required not only to subject the cement to such tests as may be mentioned in the specification, but must also satisfy the architect that it is supplied by the makers whose name is given in the specification. This latter duty may be found rather difficult where the contractor is suspected of dishonesty. If the cement is obtained direct from the makers, it may be verified by the invoice; but if the contractor obtains it from a middleman there may be collusion between these persons, with the result that, although the invoice is all in order, the cement actually supplied is not from the specified makers. In an important case where there is great doubt as to the genuineness of the cement supplied, it might be worth while to send a sample to the alleged makers for their opinion.

47. Inspection of Bricks. — The bricks to be used in the erection of this house are, as is usual, of three kinds. For all interior walls, the brickwork below the ground of external walls, and the backing of all external walls, best-quality stock bricks are specified; Crowborough purple stock bricks are used for the ordinary facings, and bright-red sand-faced bricks for the quoins and window dressings. The clerk of works, having inspected

the sand, lime, cement, and the material to be used as the aggregate of the concrete, should now look over the bricks.

The stock bricks may be examined by noting their general appearance and by striking two of them together. If they give forth a clear ringing sound, the corners do not break off easily, and they are reasonably hard and true, they may be considered to be in accordance with the specification. The red facing bricks, in addition to being subjected to a similar treatment, should be carefully examined both as to soundness and appearance. The edges particularly should be straight and truly formed, or otherwise good facing work cannot be produced. Some of these bricks may be of a light colour, indicating that they are underburnt; others, of a purplish tinge, giving forth a metallic ring when two are struck together, are overburnt, and should not be used, except, perhaps, as *bats* in the body of the wall. Excessive burning generally reduces the size of the bricks and often distorts them. The architect, on his arrival, should require the contractor to remove from the premises the underburnt bricks and not to use the overburnt for facings, and should caution him to get a better quality for the balance of the work, under penalty of having the entire lot condemned.

48. Inspection of Stone.—The points to be looked for in examining a building stone as regards its soundness and durability depend considerably on the class to which the stone belongs. Limestones should be examined for pittings and dark spots, which are signs of inferior stone. The best weathering limestones are small in grain and of a crystalline texture. Some limestones are very soft when quarried, but harden when exposed to the atmosphere after the disappearance of the quarry sap or natural moisture in the stone. When the best Portland stone is specified, a white stone should, in ordinary cases, be supplied; but sometimes a good-quality stone is found of a brown tint, and if there is no objection to it on the score of colour it may be accepted. Sand holes or pits very often occur in sandstones; all stone thus affected should not be accepted for good work. The colour of a sandstone often varies to some extent, single pieces often being found to have two shades of colour; but

variations in colour are rarely objected to by architects so long as they do not indicate the presence of any defects. Sandstones should be free from discoloration, which generally appears in streaks, and they should also be free from decided laminations. Granite should be free from black and white lumps, generally of quartz, which are termed *knots*, and also from seams or discoloration. On sounding a piece of stone with a hammer it may be discovered that some pieces, which look as good as the rest, give forth a dull sound ; this indicates that they contain hidden seams which are liable to open after the stones have been set. Such stones should be ordered to be removed immediately. Sound stones give forth a clear ring when tapped with a hammer.

SUPERINTENDENCE OF FOUNDATION WORK AND WALLING

49. Formation of Foundations.—The trenches having been excavated, and the clerk of works having checked the levels of the bottoms of the trenches and found them correct, the formation of the concrete foundation is allowed to proceed. As the trenches are the same width as the concrete foundations, no shuttering is required. In order to get the concrete of the required thickness, light pegs should be so driven in the bottom of the trenches that their tops coincide in level with the top of the required concrete. The concrete for foundation work should be well rammed, although some persons claim that good concrete is not improved by ramming, while bad concrete only appears to be improved by reason of the fact that the process of ramming brings to the surface the cement and finer particles of the aggregate. The clerk of works should watch very carefully the gauging and mixing of the concrete. He should also have previously checked the sizes of the gauge boxes, and seen that the boxes are so proportioned that when properly used the concrete will be gauged in accordance with the specification. Concrete should always be mixed on a wooden platform of boards laid flat on the ground, and not on the ground itself.

50. Mixing of Concrete.—When the concrete is mixed by hand, it should be done by men working in pairs. The aggregate

should first be measured and then the sand measured and added to it. The two materials should be roughly mixed together and formed in a heap. The cement should then be spread on the top of the heap and the material from the edge of the heap shovelled over the cement, partly as a preliminary to the mixing and partly to prevent any of the cement being blown away. The material is then turned over twice while dry, the men commencing at one end of the heap and throwing it over so as to form a heap close by the side of the original heap. The material is then turned over again, either proceeding along the mixing platform in the same direction, or placing the material back in its original position if the space at disposal is confined. The men should work opposite one another, standing face to face, and should keep time with their shovels. They should make their shovels meet at each stroke, or a portion of the material in the centre of the heap may not be properly turned over and mixed.

51. After the material has been turned over twice while dry, the water is added. This is best applied by a third man with a watering can or hose fitted with a fine-rose nozzle, the heap of material being at the same time cut into and roughly turned about by the other two men so that the water will reach every part. After the material has been properly wetted it is turned over twice, exactly as it was when dry ; it should then be at once deposited in position. The clerk of works should watch the mixing of concrete, for if the workmen find that he is not watching them they will become careless and produce an indifferent concrete, for the quality of concrete depends greatly on the care and thoroughness with which it is mixed. When, as is the case in very large works, mechanical mixers are used, it is generally considered that so much supervision is not necessary, on the assumption that, as the work is done by machinery, any slackness on the part of the workmen will not so seriously affect the quality of the resultant concrete. Sometimes concrete is formed by first mixing the sand and cement together to form a mortar and then thoroughly incorporating this with the aggregate ; but this method is not customary in British practice.

52. Boulder Concrete.—While the concrete foundation to the walls is being formed, the clerk of works should see that no large stones are being placed in with the concrete, if the specification states that all the aggregate is to be able to pass through a 2-inch ring. **Boulder concrete,** as concrete with large embedded stones is called, may be used where the construction is of great thickness, as in retaining walls ; but where only a comparatively thin layer of material is required, boulder concrete is not as satisfactory as concrete composed of broken stone.

53. Construction of Walls.—The concrete having been deposited of the required thickness, and properly stepped where the levels vary, the upper layer at such points overlapping the one below by from 1 foot to 1 foot 6 inches, first the footings and then the brickwork of the walls may be constructed. In the formation of the footings, the greatest possible number of headers should be used. The specification requires that the bricks are to be wetted before being laid. The clerk of works should see that these requirements are carried out, and that the bricks are liberally wetted in dry weather. If this is not done the moisture from the mortar is absorbed by the brickwork, and the mortar rendered so dry that it will not set properly.

54. Character of Brickwork.—In going round the works and watching the bricklayers, the clerk of works should notice whether the bricks are being properly bonded and whether each man uses a sufficient quantity of mortar. Where this is not being done, he should call the attention of the contractor to the fact and require more care to be taken in this matter. It is a common practice for bricklayers to scamp the flushing up of the cross-joints ; as this practice results in a saving of mortar, it is usually condoned by the contractor. Unless the actual operation of bricklaying is closely watched it is difficult to detect any omission in this flushing,

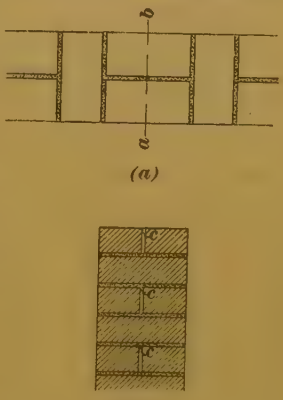


FIG. 7

as shown in Fig. 7, where (*a*) is a plan of the topmost course of a wall which is being erected. On the face, the brickwork seems to have been properly executed, all the joints having the appearance of being properly filled with mortar. But view (*b*), which is a cross-section of the wall along the line *a b*, shows that, while the bed joints are properly formed, the cross-joints have only a small dab of mortar *c* at the top; whereas, if the work had been properly executed, they would have been flushed up solid throughout. It is sometimes specified that the brickwork shall be grouted up every fourth course. This requirement cannot be very well evaded, and, if the grout is not mixed too thin, it will increase very much the strength of the work.

55. After the brickwork has proceeded for a day or so, the clerk of works may notice that during the immediately previous day the brickwork of one of the walls has been raised to the extent of more than 4 feet above the part adjoining it. He should point out to the contractor that the specification prohibits the raising of the brickwork to a greater extent than 4 feet above the part adjoining it, and ask him in the future to adhere strictly to this requirement on the penalty of having to pull down any work which contravenes this item of the specification. Another point that should be carefully looked after, and one that is sometimes mentioned in the specification, is that no brickwork shall be carried up more than 4 feet in 24 hours. The object of this requirement is to prevent the placing of too great a weight on the brickwork when it is *green*, that is, before the mortar of the joints has had time to set.

56. Composition and Mixing of Mortar.—The mortar to be used in walling should always be prepared from a hydraulic lime, although it is common in some provincial districts to make mortar from fat lime, but mortar thus prepared will not set properly in the interior of a wall. Lime mortar for walling is prepared by spreading a measured quantity of the lump or ground lime on a wooden platform and sprinkling over it enough water to slake. Too much water should not be added, as it checks the proper slaking of the lime. While the slaking is proceeding the lime should be covered with the exact amount of

sand which is to be mixed with it, and the lime should be left for from 12 to 24 hours, according to the character of the lime; at the end of that time it should be properly slaked.

After the slaking of the lime has ceased, the lime and sand must be mixed together. In all works of any size this mixing is carried out in a mortar mill, but on small works the mixing is done by hand. When the mixing is properly completed the mortar is ready for use. It is common practice to mix enough mortar to last about a week, but it is specified that only sufficient lime mortar should be mixed to supply 1 day's need. In the preparation of cement mortar it is merely necessary to measure the cement and sand in their proportions and mix them together, first in a dry and then in a wet state. Cement mortar should be used as soon as it is mixed.

57. The clerk of works should see that the slaking and mixing of the lime for mortar are properly conducted. Where lump lime is used, he should particularly watch for any lumps of underburnt lime, for these will not slake properly, and if used in the mortar are liable to continue the process of slaking, with the result that, by their expansion, they may cause injury to the brickwork. All such underburnt lumps of lime should be removed. Where ground lime is used, the clerk of works should see that it slakes properly. Ground lime is sometimes found to be air-slaked, in which case it will have lost the greater part of its strength; the use of air-slaked lime should not be permitted. In superintending the construction of brickwork in cement mortar, the clerk of works should insist on the mortar being freshly mixed. It is common for bricklayers to use cement mortar which has already begun to set, some fresh mortar being added to the old stuff to give it the appearance of being satisfactory. The use of mortar of this kind should not be permitted.

58. Rough Test for Proportion of Lime.—In the case of a building which is not of sufficient size to justify the employment of a clerk of works, the architect may determine if the mortar is being correctly mixed by placing in a small glass tube a small quantity of mortar dissolved with water to form a paste. The

tube should then be filled with water, vigorously shaken, and then the materials allowed to settle at the bottom of the tube. Being the heaviest, the sand will settle at the bottom of the tube; above this will rest any earthy matter which may, but should not, be present in the mortar, while the lime, being the lightest of the materials, will settle at the top. The relative proportions of the lime and sand will then show the proportions in which they occur in the mortar, and it can then be easily determined whether or not the mortar has been mixed of the proportions stated in the specification.

59. Damp-Proofing.—Since damp or wet soil is often encountered in excavations for buildings, many methods are adopted to keep the walls dry and prevent the entrance of surface water. Under ordinary circumstances, gravel filling and a drain of earthenware field pipes along the outside of the footings are sufficient to carry off the water, but when the soil is very wet, and in any case where there is a basement, a vertical damp-proof course of some substance that is impervious to water must be applied to the outer surface of the wall below the level of the ground. Asphalt is perhaps the best-known substance for the purpose, and when applied hot, the face of the walls being rendered in cement to produce a smooth surface and then coated with the asphalt, a water-tight job will result that under ordinary conditions will last for an indefinite length of time. In the specification it is stated that the outside face of all external walls below stone plinth and down to concrete foundation shall be rendered with neat cement $\frac{3}{4}$ inch thick.

In addition to the vertical damp-proof course, the ordinary horizontal damp-proof course must obviously be provided. It is customary in good work to provide two horizontal damp-proof courses, one at the basement-floor level and one at the ground-floor level, these being connected together by the vertical damp-proof course. The clerk of works should direct that the excavation shall not be filled in until the whole of the vertical damp-proof course has been completed. Contractors sometimes fill in the excavation as the asphalting proceeds, and in some cases, when the face of a wall below the ground level has been

exposed some time after the erection of the building, the asphalt has been found to exist only in horizontal streaks. While the clerk of works was present, the asphalt, of course, was applied in the proper manner, but while he was absent on another portion of the building, the excavation was merely filled in and no asphalt applied. In the very best work, when the brickwork has a thoroughly even and regular face, the cement rendering on the face of the walls may be omitted. The joints of the brickwork should then be raked out to the extent of $\frac{5}{8}$ inch and pointed with asphalt. Then the vertical asphalt damp-proof course should be applied in the usual manner in two thicknesses, each of $\frac{3}{8}$ inch, making a total thickness of $\frac{3}{4}$ inch.

60. Brickwork Facings. — All the brickwork having been carried above the ground level, the clerk of works should pay careful attention to the finish of the face of the wall. If one face of a brick is more regular than another, a good bricklayer will place the brick so that its better face is toward the front. He will also take a pride in properly arranging the *perpends* of the brickwork, that is, in arranging the vertical face joints throughout the whole height of the wall, so that they are in regular perpendicular lines. The clerk of works may notice, as soon as the brickwork is carried up to the ground level and facing bricks are used, that the bricklayers are using snapped headers every now and then, by this means forming two headers from a single facing brick. He should at once direct that this practice be discontinued. The use of snapped headers is fairly general in some provincial districts, but though economizing in facing bricks, the practice is not a good one, as the bonding of the brickwork is very much weakened. When, however, the face of a wall is to be built in Flemish bond and the backing is to be in English bond, the use of snapped headers is unavoidable.

61. Stone Dressings.—By this time some of the stone for the external dressings should have arrived on the site, the contractor having at an early stage received the necessary detail drawings and full-sized details from the architect. He has therefore been in a position to order from the quarry the whole of the stone required for the work, and consequently no delay has arisen.

The stone is specified to be best Portland, and the clerk of works should offer no objection to its use if from its appearance it seems to be good whitbed stone. Before any of the moulded work is commenced, the clerk of works should carefully examine the templates to see that they are well cut, and that the contours correspond exactly with those of the mouldings on the full-sized details. Should he find that one or two of the templates have been carelessly cut, he should direct that the moulded work to which these apply shall not be commenced until the architect has seen the templates. In the present case, the architect on his arrival examines the templates and directs that, with one exception where the departure from the full-sized details is very slight, the defective templates are to be destroyed and new templates cut.

62. Inferior Stone.—When the stone is being wrought, the clerk of works may notice that one piece which is being worked appears to be very much softer than the rest. He should call the attention of the architect to this fact on the latter's next visit, and subsequently, on the instructions of the architect, he should make a very careful examination of all the stone, noting particularly the hardness of each piece. Should he find that one or two pieces are very much softer than the rest, these pieces should be placed aside for the architect's inspection. The latter, when he sees them, may decide that they are basebed instead of whitbed, and consequently, although exactly similar in appearance to the rest of the stone, are quite unsuitable for external work. He should therefore direct that they shall be removed from the site. There is unfortunately practically no difference in appearance between the whitbed and basebed varieties of Portland stone ; it is only by a comparison of hardness that a person who is not an expert can detect the difference between these two classes of stone. It is of the greatest importance that only whitbed stone should be used for external work, for the basebed stone weathers very badly when used externally.

63. Formation of Openings.—In carrying up the brickwork the contractor should take into account the openings which are required to be formed. It sometimes happens that the bond

of the brickwork in a length of wall has to be broken. This break in the bond should be arranged to take place underneath an opening, as it will be less noticeable in such a position than if it were to occur in an open expanse of walling, where the break would contrast unfavourably with the regularity of the brickwork above. The clerk of works should see that, in the setting out of the stonework for the entrance doorway and the windows of the main front, the detail drawings are exactly followed. He should also see that all window sills are bedded so as to bear at their ends only, or bedded hollow and made up at completion. The object of this requirement is to allow any slight settlement of the sill to take place, in consequence of the slight compression of the joints of the brickwork, without there being any liability for the sill to be fractured in the centre. On the completion of the building the joints beneath the sills are, of course, made up uniformly throughout. The clerk of works may find that the stones forming the heads of the windows in the main front are proposed to be formed without the splays and double rabbets on the edge required by the specification; if so, he should inform the contractor that this omission cannot be allowed. He should also particularly watch the formation of the gauged arches over the remaining windows. Arches of this kind must be carefully set out, and each voussoir rubbed down to the exact size required.

64. Internal Walls.—The brickwork of both the external and internal walls should be carried up at approximately the same rate. If, for any reason, the brickwork of the internal walls cannot be erected until the external walls are nearing completion, care should be taken to allow for a strong junction being made between the two portions of brickwork. It will not be sufficient merely to leave toothings in the external walls at the points where the internal walls occur, for this will not result in the formation of a very strong connection between the internal and external walls. The correct arrangement is to construct a small portion of each internal wall and then to rack back this portion in two or three wide steps, toothings in addition being left in such portion of the wall, in order to enable the

main portion to be properly joined on. This is shown in Fig. 8 (*a*), where *a* is a section of the external wall and *b* a small portion of one of the internal walls, which is racked back and toothed as described. Another method of obtaining the same result is shown in (*b*) ; in this case the internal wall *c* is racked back in $2\frac{1}{4}$-inch offsets. The new work then bonds on without any toothing of the wall being required.

65. Chimney Breasts and Flues.—The clerk of works should see that, in the construction of the chimney breasts, a chimney bar is provided to every fireplace opening, and that the ends

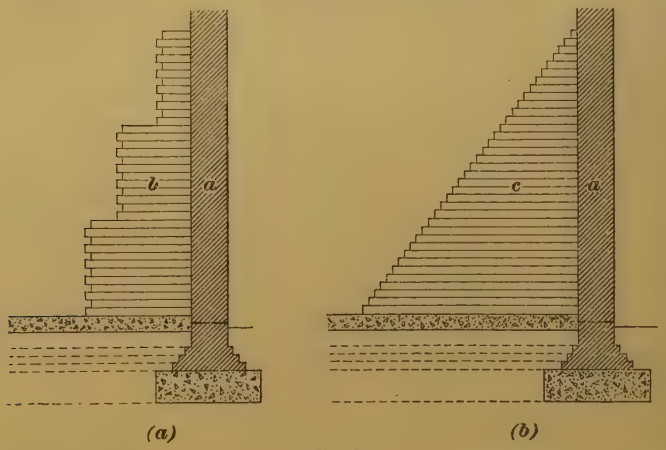


FIG. 8

of the bar are properly split, turned up, and built into the brickwork of the jambs. The chimney bar prevents the jambs being pushed out by the thrust of the arch over the fireplace opening and, incidentally, serves as the centring for the arch. When the construction of the flues is commenced, the clerk of works should see that any twists or turns in the flues are constructed in a careful manner and so that there are no abrupt changes of direction. He should also see that the pargetting of the inside of the flues is properly done, and should direct the workmen to take care, at the completion of this part of the work, to clear out any droppings which may have accumulated at the bends in the flues. A smoky chimney is sometimes due to the carelessness of workmen who have not taken the trouble to clear

out the droppings in the flue, with the result that, at one or two points, the flue is almost entirely blocked. Openings should be left at the bottoms of all bends in flues in order that droppings may be easily cleared out.

COMPLETION OF GENERAL CARCASS WORK

INSPECTION OF TIMBER

66. Defects in Timber.—During the time that the construction of the walls is proceeding, the timber for the framework of the floors and roof should have arrived on the site and have been inspected by the clerk of works. It is necessary for him to consider three things: (*a*) the general quality of the timber, (*b*) whether it is the kind described in the specification, and (*c*) whether it is of the sizes described in the specification. With regard to the first point, the duty of the clerk of works may be described as that of looking for defects. He should therefore examine the timber for sapwood, shakes, large knots, waney edges, and similar easily detected defects, and should also pay attention to its general character, noting whether it is straight or crooked in the grain, and whether bright and lustrous when fresh cut with the saw; a dull appearance denotes weakness and unreliability. He should also examine the timber for signs of dry rot. In the present case, he finds the timber of reasonable quality, but some lengths, which have waney edges or are badly affected by shakes, he condemns and orders to be removed from the site.

67. Character of Timber.—The determination of whether the timber is of the character stated in the specification is much more difficult than noting the defects in timber. There is, of course, no difficulty in knowing one kind of timber from another; the majority of people who have nothing to do with building work know a piece of deal or a piece of oak when they see it. But only an expert can distinguish between varieties of timber of the same class. The brands of fir timber are now very different from those of an earlier date; consequently, when, as too frequently happens, a specification is copied from one several

years old, brands of timber are sometimes mentioned which are no longer on the market. Knowledge of the various kinds and brands of fir timber can only be obtained by extensive practical experience. Even then, a person familiar with the timber shipped to a certain port may find, on going to another locality, that the timber there obtainable is in many cases of different brands.

68. Dimensions of Timber.—The checking of the dimensions of the timber is obviously a matter that requires care rather than any special knowledge. It should be borne in mind, however, that timber shrinks to a certain extent in drying, and that there is a saw cut to be allowed for in timbers of small scantling, and thus the sizes are slightly decreased accordingly; for instance, the depth of an $11'' \times 2''$ joist will rarely measure more than $10\frac{3}{4}$ inches. This fact must be taken into account in checking the dimensions unless the specification states that the sizes are finished sizes, which method is sometimes adopted with regard to joinery work, but very rarely with regard to the timber of the carcase of the building. When this method is used, the sizes specified are those obtained by making the necessary slight deduction from the current sizes of timber.

CONSTRUCTION OF FLOORS

69. Construction of Ground Floor.—The clerk of works having found the timber to be of the specified character and sizes, and having passed it as satisfactory with the exception of those lengths which were condemned as defective, the construction of the floors may be proceeded with. In cases where the joists have to rest on sleeper walls, great care should be taken that these walls are built properly. The 6-inch thickness of concrete under the ground floor having already been laid, the erection of $\frac{1}{2}$-brick sleeper walls will be commenced. These are required in all the best work to be built honeycomb in order to admit of the free circulation of air round the joists. The clerk of works, however, may notice that the bricklayers are leaving such large spaces between the bricks that the strength of the sleeper walls

is being injuriously affected. He therefore directs that these spaces shall be reduced. The sleeper walls having been carried to the required height, the plates are bedded on them, and the carpenters proceed to fix the ground-floor joists. Joists that have a slight curve in the direction of their length should always be laid with the convex side uppermost, for, if laid in the reverse manner, they will tend to sag.

70. The clerk of works should check the spacing of the joists to see whether the requirement of the specification that joists should in no case be spaced more than 15 inches from centre to centre has been followed. He may find that in one room the carpenters, to save putting in an extra joist, have spaced the joists 16 inches centre to centre ; he should direct the spacing of the joists to be altered so as to comply with the specification. It is specified that beneath solid floors, such as tile, wood block, and granolithic floors, 6 inches of concrete is to be laid. The clerk of works should particularly notice this portion of the work. Contractors, instead of using concrete, will often substitute brick rubbish with scrapings of mortar from old bricks, or other similar material, and skim the top over with cement to give it the appearance of concrete, on the principle that, as this filling-in material is never seen, anything is good enough. Where concrete is specified, its provision should be insisted on, and the 6-inch bed of broken brick, or other hard dry material, specified to be laid under the concrete, should not be forgotten.

71. Construction of Upper Floors.—When the brickwork of the wall has been carried well above the level of the first floor, the carpenters may desire to proceed with the construction of this floor. Since, in the present case, the rolled-steel joists used in some of the rooms have not been received, only the floors of the smaller rooms can be commenced. When the steel joists arrive, they should be checked by the clerk of works to determine if of the correct sizes ; the invoice will show if they have been obtained from the steel firm whose name was approved by the architect. In this case, the clerk of works in measuring the lengths of the steel joists discovers that one of them, when fixed in position, will have a bearing of only 3 inches at each end,

instead of 9 inches at each end, as shown on the working drawings, and orders the joist to be removed from the works and one of the correct length ordered. The contractor points to the delay that will result, and suggests that the brickwork be corbelled at each end of the joist so as to give a 6-inch bearing at each end. As the clerk of works cannot allow such an arrangement, the contractor must raise the point with the architect, who refuses his consent.

72. As the work to the floor proceeds, the clerk of works must carefully watch its construction. He should check the spacing of the joists, note that the wall plates are halved and tied at the angles, and that the trimmers are $\frac{1}{2}$ inch and the trimming joists are 1 inch thicker than the ordinary floor joists, as required by the specification. On the working drawings the trimmer adjoining every hearth is shown to be tusk-tenoned to the trimming joists at each end, with the centre portions of the tenons carried through the trimming joists and pinned on the other side. The clerk of works may find that in carrying out this work the carpenters are adopting a form of tusk tenon in which the tenon does not extend through the full thickness of the trimming joists. He should condemn all trimmers framed with tenons of this description and direct that the method shown on the drawings be adopted. He should also see that the trimming for the staircases is carried out in a satisfactory manner. Though the method of not running a tenon through the full thickness of the timber into which it is mortised is quite common, it is not as sound work as that of running the tenon through and pinning it on the other side.

GENERAL PROGRESS OF WORK

73. Position of Openings.—In the present case, while the carpenters are at work on the first floor, the bricklayers finish the carrying up of the walls to the levels required. In forming the openings in a portion of the front wall, the foreman of the bricklayers sets out the work so that the openings are centrally over those below, this being the general rule in well-designed

work. The clerk of works, however, sees that the position of two of these windows is figured in such a way that the windows will not come centrally over the ones below. He therefore directs the bricklayers not to proceed with the work on this portion of the wall until the architect has been consulted. He then informs the architect, when the latter next visits the site, that there is some uncertainty as to the exact position of these windows, and is told that the figured dimensions of the plan are to be exactly adhered to.

74. Completion of General Brickwork.—When the framework of the first floor is constructed, the carpenters start work on the attic floor. A small portion of the first floor, however, must be left uncompleted until the arrival of the steel joist ordered in the place of the one which was found to be too short. The bricklayers also continue the raising of the walls until the roof is approached. When the level of the eaves is reached, the top of the brickwork is finished off in a very careful manner. Then the head-stones to the front bay are laid by the masons, particular attention being given to the proper alinement of these. The clerk of works should see that the joints between each of the cornice stones are formed by means of cement joggles or as required by the nature of the work. In examining some of the stones, he may find one which is so worked that when laid in position it will not be on its natural bed; that is, the laminations of the stone will be horizontal instead of being vertical, as required by the specification. He should condemn this stone, for, if it is used, portions of the facework will flake off in course of time. The general rule that stone is to be laid on its natural bed does not apply to cornice stones; these must be laid so that the laminations of the natural bed are vertical and run at right angles to the face of the wall. When the general work to walls has been completed, the bricklayers proceed with the construction of the chimney stacks, and carry them up to the level of the under side of the capping, which is then laid by the masons. In the walls the brickwork is carried up to the wall plate.

75. Protection and Security of Work.—As the clerk of works is making a general tour of the building he may notice that one

of the window sills on the ground story has been left unprotected, and that in consequence a corner has been broken off by a brick dropping from above. He should direct that this sill be removed and replaced by a sound one. A careful contractor always takes care that all window sills and large projecting mouldings in the lower part of the building are protected by boards, so that there is no risk of their being broken or chipped. The clerk of works may notice, on the same inspection tour, that the workmen are commencing to remove, or, as it is more usually termed, *to strike*, the centring of one of the window arches while the brickwork is still in a green state. He should order them to desist, and call the contractor's attention to the clause in the specification which requires that no centring is to be struck until the architect shall have given his consent to its removal.

CONSTRUCTION OF FRAMEWORK OF ROOF

76. Wall Plates and Purlins.—When the brickwork has been carried up to wall-plate level, the wall plates which provide a bearing for the ends of the common rafters are bedded. In the present instance, the roof is hipped and the ends of the hips are provided with dragon ties according to detail drawing. The clerk of works must pay particular attention to the formation of these dragon ties, as good carpentry is required for work of this description, and if not properly superintended the work is liable to be scamped. The roof framing cannot be erected immediately after the wall plates are bedded, for the framed partitions which carry the purlins must first be erected. The carpenters, therefore, will proceed with their work in erecting partitions. When this has been done, the purlins are placed in position, any trusses or struts necessary to carry them at the points where framed partitions do not occur having been previously erected.

77. Fixing of Common Rafters.—The common rafters are cut to the required lengths and fixed in position. They are, of course, trimmed round all chimney stacks and round the four dormer windows which occur in the roof of the building.

The clerk of works should see that this trimming is properly executed, and that the rafters are cut so as to fit accurately over the wall plate and against the ridge and hips. He should also check the spacing of the rafters. The roof framing having thus been satisfactorily completed, the roof is ready to receive the covering.

DRAINAGE WORK

INSPECTION OF DRAINAGE MATERIALS

78. Pipes, Gullies, and Manhole Covers.—While the general construction of the building is proceeding, the pipes, junctions, gullies, and manhole covers for the drainage work should arrive on the site. They should be inspected immediately on their arrival. The glazing of the pipes, junctions, and gullies should be carefully examined. Should the specification require that the gullies are to be of a certain type, as given in the list of a stated maker, the clerk of works may find that gullies of another and slightly inferior type have been substituted. In that case, he should direct that the gullies supplied shall be removed from the site and gullies of the specified type substituted. As the contractor, however, sees that, instead of saving money in the manner he had anticipated, he is likely to be put to increased expense, he may contend that the type of gully supplied is, if anything, better than that specified, and states that he will not remove the gullies until the architect has been consulted. The architect, of course, should confirm the clerk of works' directions as to the removal of the gullies.

79. Materials for Mortar and Concrete.—The mortar for drain laying must always be cement mortar, and is often specified to contain a much larger proportion of cement than mortar used in the construction of ordinary walling. Sometimes neat cement is specified. As so much depends on the proper carrying out of drainage work, it is desirable that, if anything, greater strictness should be observed in inspecting the materials used for this work than is customary in inspecting the materials to

be used for ordinary building purposes. The cement should be absolutely sound and the sand should be the best procurable. The concrete should be of a reliable character, but as this material is used only for the purpose of providing a solid foundation for the pipes, it need not be of such exceptionally good quality as the mortar, on the soundness of which the strength of the joints depends.

CONSTRUCTION OF DRAINS AND MANHOLES

80. Laying of Drains.—When the brickwork of the building is practically completed, the laying of the drains is commenced. The clerk of works should check the setting of the gullies and the levels of the drains as the work proceeds, in order that the drains may have their correct falls. He should see that the concrete required by the specification to be provided underneath the pipes is of the specified thickness. When the actual laying of the pipes is commenced he should carefully watch the workmen to see that they get the pipes in proper alinement, with level inverts, and that the surplus mortar from the joint is scraped from the inside of each pipe as the work proceeds. Should he find that, owing to an error in setting out, one length has a kink in the centre, he should direct that the length of drain shall be taken up and relaid in a straight line.

81. Construction of Manholes.—The foundations of the manholes are constructed at the same time as the concrete for the drains is laid, and the work to the manholes is proceeded with when this can be done without hindering the operation of drain laying. The manholes must be rendered inside in cement and the bottoms benched up, as shown on the drawings. The clerk of works should see that this work is properly done, and should look after the corbelling over of the sides of the manholes at the top to receive the cast-iron covers. When this latter work is commenced he may find that the bricklayers are making the projection of each course of corbelling as much as 3 inches. If so, he should direct that work thus constructed shall be rebuilt, and should inform the contractor that in this work of reconstruction and in all subsequent work no course of brickwork must

be corbelled out more than $2\frac{1}{4}$ inches beyond the face of the course immediately below it.

82. Testing of Drains.—On the completion of the drainage work, the drains must be tested with the water test in the usual manner. The clerk of works must inform the architect that the drainage work is ready to be tested, so that the latter may arrange the time of the test with the contractor and make a point of being present. In the case of a very large building, it is often desirable to test the drainage system in sections. In the present instance, when the water test is applied to the drains, first one length of drain and then another being tested, it is found that, with the exception of two lengths of drain, the drainage is satisfactory. In one of these two lengths the only defect is a leakage at one of the joints ; this is very soon remedied. In the case of the other length of drain, it is found that practically all the joints for a distance of about 20 feet from one of the manholes are defective and leak badly. It appears that an inexperienced man worked on this portion of the work, but that after he had proceeded for the short distance of 20 feet his incompetence was noticed by the foreman and he was given other work. The architect directs that the portion of the drain in which the defective joints occur is to be taken up and relaid. On the completion of this work of reconstruction the drain is again tested and is found to be satisfactory.

BUILDING SUPERINTENDENCE

(PART 3)

ROOFING, JOINERY WORK, AND PLASTERING

SUPERINTENDENCE OF ROOFING

INSPECTION OF ROOFING MATERIALS

1. General Condition of Building.—The building of which the superintendence is here being described is very well advanced in construction. The general brickwork of the walls is completed, the openings in the walls are all formed, all the joists of the floors and rafters of the roof are in position, and the chimney stacks are completed. Therefore the next step in the construction of the building is the laying of the roof covering. The completion of the roof is welcomed by every person concerned in the erection of a building, for then the greater portion of the remaining work can proceed without any risk of its being delayed by bad weather.

2. Character of Roof Covering.—The roof covering is to consist of first-quality red hand-made Broseley or other roofing tiles hung to $1\frac{3}{4}'' \times \frac{3}{4}''$ sawn tiling battens, laid on felt and $\frac{3}{4}$-inch rough boarding. The tiles are to be formed with nibs, by means of which they are hung, and in addition they are to be nailed at every fourth course. Where the question of expense does not need to be considered, all the tiles may be required to be nailed.

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The nails used are $1\frac{3}{4}$-inch galvanized, two being used to each tile. The gauge is specified to be 4 inches. This represents ordinary sound construction. In cheap work, either the boarding or the felt is frequently omitted, while sometimes in very cheap work neither boarding nor felt is used.

3. Inspection of Boarding, Battens, and Felt.—While the construction of the general brickwork of the building was proceeding, the materials for the roof covering arrived on the site. When inspecting the boarding, the clerk of works may find that many of the boards are very knotty and also that some of them have waney edges. Should he not, however, consider the character of the boarding to be so bad as to justify its rejection, he should call the attention of the architect to this matter on the occasion of the latter's next visit to the building. The architect, after looking through the consignment of boarding, may decide to reject all boards in which dead knots, however small, are found, and also such of the boards as have waney edges of a pronounced character. The battens are found to be satisfactory and the felt to be of strong sound material.

4. Inspection of Tiles.—On the arrival of the tiles on the site, the clerk of works should first examine the invoice so as to find if the tiles are there described as being first-quality red hand-made Broseley tiles. He should then make an examination of the tiles to see whether their quality is up to the standard required by the specification and that they have not suffered damage in transit.

The specification requires that the tiles are to be equal to samples approved by the architect. These samples should be sent to the clerk of works in order that he may compare them with the tiles furnished. In making this comparison, a clerk of works should appreciate the fact that the samples supplied are picked tiles, and that it will be hardly possible for every tile to equal them in quality. It will suffice if the majority of the tiles come up to this standard, provided that all are of reasonable quality.

5. When inspecting the tiles, the clerk of works may find that one or two of the hip tiles have been a little twisted in

burning. These should not be used, neither should any tile that has been broken in transit. Hand-made tiles are somewhat more porous than those that are made by machinery; but they are preferred by most architects because of their pleasing colour. Most varieties of machine-made tiles have hard crude colourings. The colour of such tiles does not soften and improve in course of time, whereas hand-made tiles become of a still more pleasing colour after being subjected to the effects of the atmosphere. Such tiles, on roofs facing north and north-east, become, in course of time, covered with a layer of vegetation. The roof slopes facing in these directions thus become of a green tint, and the building loses the, to many people, objectionable appearance of having been newly built.

LAYING OF ROOF COVERING

6. Laying of Boarding, Felt, and Battens.—The first step in the covering of a roof consists in laying the boarding, if such is specified. In all ordinary cases, as in the present building, the boarding is laid at right angles to the rafters and nailed to them. In light steel roofs where the boarding is carried direct by purlins and no common rafters are provided, it is evident that, if the boarding were laid at right angles to the purlins, the trusses would not be in any way laterally stiffened by the boarding. It is therefore customary in such cases to lay the boarding diagonally. In addition, the lines of the boarding are reversed on the opposite side of the roof. By the adoption of this arrangement of boarding, the trusses are laterally stiffened both by the purlins and the boarding.

After the boarding has been fixed the felt is laid. This should be properly lapped and nailed at the joints to the boarding. The next step is the laying of the battens, which, of course, run in all cases at right angles to the rafters. The spacing of the battens is regulated by the gauge of the tiling, which is specified to be 4 inches. In this instance, the clerk of works finds that the battens are being spaced at $4\frac{1}{2}$-inch centres, which will result in the tiles having a greater gauge and consequently a less lap than that specified. He therefore draws the attention of the

contractor to this inaccuracy in the setting out of the battens, and directs that it shall be immediately rectified.

7. **Laying of Tiles.**—The clerk of works should see that in the laying of the tiles they are properly nailed as required by the specification, that a double course of tiles is provided at the eaves, and that, in the necessary cutting of the tiles at verges, hips, and valleys, no tile is provided that is less in width than half the ordinary width of a tile. The nailing of the tiles needs close supervision, as otherwise probably only one nail to each tile will be used. The clerk of works must also give attention to the setting of the ridge and hip tiles. As regards the former, which are of half-round section, he should see that they are laid on a good thick bed of lime-and-hair mortar and then jointed and pointed up in cement. The hip tiles are specified to be securely nailed and then pointed in lime mortar. Half-round ridge tiles are not nailed unless they have lapped joints, in which case the nail of one tile is covered by the overlap of the next.

8. On the construction of the verges being commenced, the clerk of works noticed that the tiles at these points were being packed up with a thick bed of mortar, but that the course of tiles which was specified to be laid flat underneath the ordinary tiling was not being provided. He therefore instructed the tilers to insert this course of tiles, bedding them on a $\frac{1}{2}$-inch thickness of lime-and-hair mortar, which is just sufficient to give the tiling a sufficient tilt to prevent the rain-water from the roof from running over the verge. The ordinary tiling is then bedded and pointed in cement mortar.

9. **Covering Roofs With Slates.**—Where roofs are slated, the process of laying the covering is very similar to that customary in the case of tiled roofs. In the best work, boarding, felt, and battens will be provided, but in the large number of buildings that are erected as cheaply as possible only battens are used. In slating, as in tiling, the gauge of the covering determines the spacing of the battens, and, the gauge being known, the battens may be correctly spaced without any trouble. Where, however, Westmoreland or other random-sized slates are used, it is necessary to sort the slates into batches of approximately equal size

to form courses. Then the slates are laid in courses diminishing in size from eaves to ridge, this being the arrangement that is found to be of the most pleasing appearance. The sorting of the slates and the formation of the courses should be watched by the clerk of works, and before the laying of slates of this character is commenced, the architect should direct the contractor temporarily to slate a small strip of roof for his inspection. The spacing of the battens will necessarily be determined by the size of the several courses of slates.

GUTTERS, FLASHINGS, AND GENERAL ROOF FINISHINGS

10. Fixing of Eaves Gutters.—The gutter for the main eaves is specified to be a $4\frac{1}{2}'' \times 4\frac{1}{2}''$ heavy cast-iron moulded gutter, and that for the back addition a 4-inch heavy cast-iron gutter of half-round section. The first is to be bolted and screwed to the fascia, and the second is to be supported on wrought-iron brackets screwed to the feet of the rafters. A smaller gutter is to be used round the bays and to the roof over the seat on the garden front. The clerk of works must see that the lengths of guttering are properly fixed, the joints between the several lengths soundly made in red lead, and that the outlets are provided where required. In this instance he finds that, owing to an error in measurement on the part of the contractor, an outlet has been provided in a wrong position, and that if a rain-water pipe is fixed underneath this outlet it will pass over the brick dressings at the sides of one of the windows. He therefore orders the length of guttering to be taken down and replaced by a length having the outlet in its correct position. He must also see that the gutters are given sufficient fall, and that there is no sag at any point throughout the lines of the guttering. It will be desirable in all cases for the clerk of works to examine the drawings before any work is commenced, in order to make sure that the outlets of the gutters correspond in position with the gullies beneath, and that unnecessary swannecks are avoided. All cases where they do not coincide should be brought to the attention of the architect, who must decide whether the position of the outlets or of the gullies is to be followed.

11. Some architects specify that gutters are to be scraped down and given one coat of paint by the manufacturers. This requirement prevents the manufacturers from applying a coat of thick inferior paint in order to disguise any rust scales that may be present, and thus avoid the trouble of scraping the metal. In all cases it is most desirable that a coat of paint should be given to rain-water gutters and pipes immediately they are delivered on the work and previous to their being fixed.

12. Fixing of Rain-Water Pipes.—At the same time as the gutters are being fixed the rain-water pipes should be put in position. These are specified to have ears cast on for fixing, and are to be fixed by means of large rose-headed nails. The clerk of works must see that the rain-water pipes are of the size and quality specified, and that the joints are properly run with lead as specified. Should he find that the first rain-water pipe to be fixed is placed so as to abut immediately on the face of the wall, he should order this to be refixed and blocked out 2 inches away from the wall, as required by the specification. The principal object of this requirement is to enable the pipes to be painted all round. Pipes fixed close up to a wall cannot be properly painted at the back, and thus tend to rust through at this point. Another advantage gained by keeping the pipes away from the face of the wall is that there will be no necessity to damage strings or small projecting mouldings by cutting into them to run the pipes through, as would otherwise be the case.

Although it is a general custom to joint rain-water pipes, some persons consider that it is desirable to leave the joints open. The reason given is that, if the joints are left open, warning is immediately given of any stoppage at the bottom of the pipe by an overflow at the first joint, whereas, if the pipes are jointed, water will rise in them up to gutter level. Then, if a sharp frost should occur, the pipe will be liable to burst. Also, there is considerable difficulty in repairing a length of pipe if the joints are run with lead.

13. Construction of Lead Gutters.—When a roof is finished with a parapet, and when a valley gutter is formed between two roofs, a lead or zinc gutter is required. In all work of a

good character lead should invariably be used; zinc is by no means a reliable or durable material. Lead gutters are usually specified to be formed of 6-pound or 7-pound lead, and, when work of this nature is about to be commenced, the clerk of works should first check the weight of the lead provided. If he has had considerable experience, he will usually be able to tell from a brief inspection whether the lead is of the weight specified, for the thickness varies in direct proportion to the weight. Also when, as is customary, the lead is delivered in large sheets, the clerk of works can ascertain the weight of the lead from the stamp on the sheet, which is applied at the rolling mills. But when there is the least doubt as to the weight of the lead supplied, either the thickness should be checked by a gauge specially constructed for the purpose, or a piece of the lead weighed and measured. The better method is to use a gauge, with which both an architect and a clerk of works ought to be provided. If in any case lead of less weight than that specified is found to be used, not only should the lead at once be ordered to be removed and lead of the proper weight substituted, but also a very strict watch should be kept on the work in the future. A contractor who purposely supplies lead of less weight than that specified must be regarded with the greatest suspicion.

14. Fall of Lead Gutters.—It will be necessary in all cases for the clerk of works to watch very carefully the laying of lead gutters, in order to see that the drips are provided at the necessary intervals and that the fall is in accordance with the specification. In the case of all parapet and valley gutters, it is to the contractor's advantage to provide a less fall than that specified, for by so doing the width of the gutters at their upper ends is materially decreased, and consequently less lead is required. The width of the lead provided should, of course, also be checked, as, if the width is insufficient, the water may be liable, during heavy rain storms, to rise over the top of the lead and penetrate the roof.

15. Gauges for Lead, Zinc, Etc.—A gauge for any one particular material is usually made of circular form, but an architect or clerk of works should obtain a gauge applicable to several

materials. Gauges of this latter description are usually made in the form of a pocket-knife with two or more steel blades. A very useful gauge is shown in Fig. 1 (*a*) and (*b*), in which (*a*) represents one side of the gauge and (*b*) the gauge turned over so as to show the other side. In all cases the description on the blades of the gauge refers to the divisions below the description. The zinc gauge from 8 to 20 is shown at *a*, a plate-glass gauge from $\frac{1}{8}$ inch to $\frac{1}{2}$ inch is shown at *b*, the Imperial Standard wire gauge from Nos. 19 to 30 is shown at *c*. Blade *d* in (*b*), which is the reverse side of the blade *a* in (*a*), is the gauge for from 3-pound to 12-pound lead. Blade *e* in (*b*), which is the reverse side of *b* in (*a*), is the sheet-glass gauge for from 13-ounce to 42-ounce glass. Blade *f* in (*b*), which is the reverse side of *c* in (*a*), is the Imperial Standard wire gauge from Nos. 10 to 18. The divisions 17 and 18, however, are hidden by the case *g*, into which the blades shut when not in use.

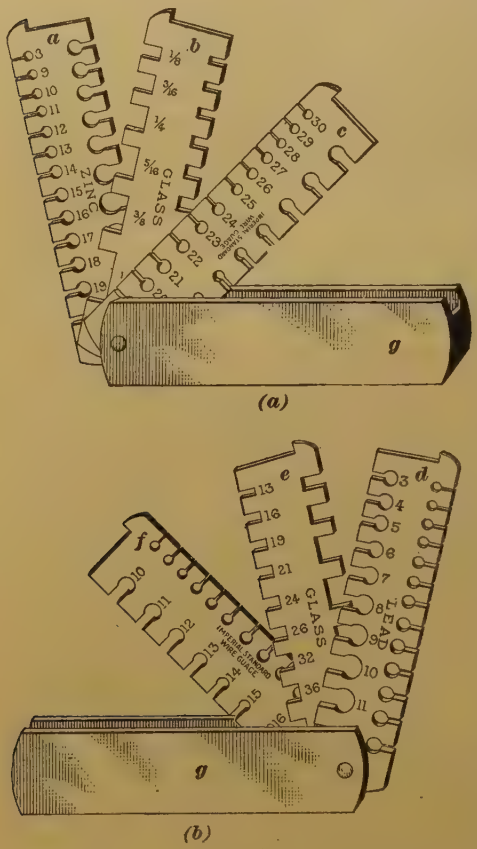

FIG. 1

16. The gauge shown in Fig. 1 is a **plumber's gauge,** with the addition of the blade *c*, *f*, which contains the Imperial Standard wire gauge. When testing a piece of lead, zinc, galvanized iron, or other metal with a gauge, first one and then another

indentation of the gauge should be slipped over the material until an indentation is found that, by means of a slight pressure, can be made to slip closely over the material. This indentation will represent the gauge of the material.

17. Flashings to Parapet Walls.—Wherever a lead parapet gutter occurs, it is necessary to provide a cover flashing to extend over the upturned edge of the lead gutter and prevent water from getting between the edge of the gutter and the parapet wall. A cover flashing is therefore specified in all cases where a lead gutter is provided, and, to be satisfactory, should be properly dressed down over the upturned edge of the lead gutter. The clerk of works, in inspecting cover flashings of this kind, should note that the flashing is of the width specified, that a horizontal joint in the brickwork is raked out to receive the top of the flashing, and that when the flashing is inserted in the joint it is properly wedged up and pointed in cement on completion. Either hardwood or lead wedges may be adopted for wedging up flashings, lead wedges being considered the more preferable.

18. Flashings to Chimney Stacks.—The flashing at the sides of the chimney stacks is specified to consist of soakers with a cover flashing. The flashing at the back of each stack is to consist of the customary back gutter, and the front of each stack is to be finished with an apron extending over the tiles.

The clerk of works must see that the lead is of the weight specified, in this case 4-pound lead for the soakers, 5-pound lead for the cover flashings and aprons, and 6-pound lead for the back gutters. Sometimes soakers are specified to be of 5-pound instead of 4-pound lead, but this extra amount of lead, in addition to increasing the cost, is disadvantageous, as the additional thickness tends to prevent the slates from lying closely together. In the present instance, the clerk of works finds that, after he has spoken to the plumbers regarding the dressing down of the cover flashings over the upturned edge of the soakers, the workmanship is of a very good character.

19. Finishings to Gables and Dormers.—The timber framing of the front gable and the barge boards to such gable are specified

to be of oak. The architect, in addition to providing a fully dimensioned ½-inch detail, himself superintends the setting out of this work in the contractor's workshop, as the proper finish of the gable will considerably affect the appearance of the building. The clerk of works must see that the work is properly executed when it is to be carried out on the building, and that the spaces between the vertical studding are solidly filled in with brickwork, which is afterwards finished on the face with rough cast. The framing of the small gable to the dormer on the garden front is similarly formed of oak, but the spaces between the studs are merely finished with plaster, no brickwork being here provided.

The sides of the dormer, in all cases, and the face of the gable at the back of the building are hung with tiles. The clerk of works must see that the tile hanging is correctly carried out, with the tiles laid to the specified gauge, and that the flashings to the sides and fronts of the dormers are as specified. These are to be constructed similar to the flashings at the sides and fronts of the chimney stacks, with the exception that no cover flashing is to be placed over the soakers provided at the sides, these being in this case covered by the tile hanging.

SUPERINTENDENCE OF PARTITION WORK

20. Half-Brick Partitions.—All the partitions on the ground floor and almost all on the first floor of this building are constructed in brickwork, the planning of the first floor having been arranged so that the partition wall comes immediately over the walls below. This placing of supports over supports is always desirable where possible. At one time it was an essential requirement of good planning, but now, when steel joists are so largely used for carrying walls and partitions, this rule is often entirely disregarded. The ½-brick partitions of this building were constructed at the same time as the rest of the brickwork and were superintended by the clerk of works. He then looked after the proper bonding of the bricks, and, on completion of this work, carefully tested the verticality of each wall with a bricklayer's plumb-rule, and, finding in one case the top portion

of a partition wall to be slightly out of the upright, he ordered this portion to be rebuilt. A $\frac{1}{2}$-brick wall is much more liable to get out of upright during its erection than an ordinary wall of greater thickness. Therefore, all $\frac{1}{2}$-brick partition walls should be carefully plumbed on completion.

21. Stud Partitions.—All other partitions in this building are required to be formed of timber framing. Those in the attic story were erected when the roof work was in hand, but the remaining partitions must now be fixed. When superintending the erection of stud partitions, the principal point to be watched is the arrangement of the bracing, by which means the weight of the partition should be transferred to the walls. In good work, the partitions are first laid out on the ground adjoining the building, and properly framed together, the shoulders being tightly drawn up with iron pins, termed *draw bore pins*. The parts of the framing are then numbered, the framing taken to pieces, and re-erected in position inside the building. By these means good and accurate workmanship is obtained.

22. Plaster-Slab Partitions. — Frequently, in town work, plaster-slab partitions are used; indeed, in the erection of office buildings, they may be said to have practically superseded the stud partition with its hollow spaces in the centre. They are more fire-resisting and more sanitary and take up less space, which is a great consideration in city offices. One of the principal points to be considered in superintending the erection of plaster-slab partitions is the securing of the partitions at the ends where they abut against a wall. Sometimes all that is done is merely to cut the slabs so that they fit close up against the wall, and then make the joint between the partition and the wall in plaster of Paris. This arrangement, however, does not give the partition a satisfactory hold at its junction with the wall. A better method consists in nailing a vertical wooden fillet to the face of the wall in such a position that the groove which is usually provided for bonding purposes in the centre of the blocks enables the partition to fit over the fillet. A more secure method, however, is to cut a chase from 1 to 2 inches deep in the face of the wall throughout the height of every second or third slab. The blocks are run

into the chases and the joint made good with plaster of Paris or cement, a very strong connection being thus obtained.

23. The junction between a slab partition and the floor and ceiling is usually made by means of a fine joint of plaster of Paris, which material is generally used for the jointing of the slabs. Where slab partitions are used, the door frames must be solid frames of equal thickness to the finished thickness of the slab partitions, the joint between the plaster and the frame being then covered with an architrave moulding. The backs of the door posts and the top of the door heads must be grooved to receive the plaster.

COMMENCEMENT OF JOINERY WORK

INSPECTION OF MATERIALS FOR JOINERY WORK

24. **Characteristics of Good Wood for Joinery.**—As the wood used for joinery work is not, in the majority of cases, called on to bear any loads, its strength is of comparatively slight importance. Since, however, it must be wrought and brought to a fine finish, certain defects, which in the case of good strong timber for carpentry work would be considered trivial, must be seriously taken into account for this work. Good joinery wood should be of straight and even grain, well seasoned, and free from sap, large knots, and the other common defects to which timber is liable.

25. **Examination of Wood for Joinery.**—When wood for joinery work is inspected, it is necessary, in addition to examining it as if it were timber for carpentry work, to pay particular attention to the following points. It should be particularly noted whether or not the timber is well seasoned. Timber nowadays is unfortunately rarely allowed the time to become so well seasoned as was the case even 20 years ago. No timber, however, that is not reasonably well seasoned should be used for joinery work. When inspecting floor and wainscoting boards, it is necessary to see that the specified width is not exceeded. The reason for limiting the width of these boards is that if any shrinkage occurs it will not be so noticeable where boards of

comparatively small width are used ; also, very wide boards are liable, when shrinking, to crack down the centre.

26. Prevention of Shrinkage in Finished Work.—The specification requires that, as soon as the contract is signed, all the timber for both the carpenter's and the joiner's work is to be cut out and stacked. By this means the timber is allowed all possible time to be subjected to the action of the atmosphere in the form in which it is to be used in the building, in order that any shrinkage which may occur may take place before the timber is fixed. It is further provided that the whole of the joiner's work is to be framed together as soon after the commencement of the work as possible and at least 2 months before being fixed. The members of the framing, however, should not be tightly wedged together until immediately before being fixed. By that time the slight shrinkage which almost inevitably occurs will have taken place, and the wedges may be driven home and the framing made generally tight and secure without there being the risk of its becoming loose, as it would if the process of framing had been commenced and finished in one operation. One of the first duties of the clerk of works is to see that the timber is cut out as required ; this will, of course, entail a visit to the contractor's workshops.

FINISHING OF FLOORS

27. Character of Finish to Floors.—The flooring for the entrance hall and the three principal rooms of this building is specified to be $3'' \times 1''$ red-deal grooved-and-tongued flooring. Flooring of this kind is often required to be secret nailed, in which case the form of the joint must be specially arranged for this purpose. Other floors are to be of similar material, but in batten widths with rabbeted joints ; that is, the greatest allowable widths for such latter flooring is 7 inches, which is the maximum width for battens. The heading joints are to be splayed. The scullery floor is to be laid with $1\frac{1}{4}$-inch pitch-pine wood-block flooring. The object of limiting the width of the flooring to be used in the best rooms is to produce a superior kind of floor throughout this portion of the building. The specification

further provides that 3″ × 1″ oak mitred borders are to be provided at the junction of the flooring with all hearths and round the sinking for the front-door mat in the vestibule.

28. Laying of Floors.—When the flooring arrives on the site, it should be carefully examined by the clerk of works, who should note not only the quality of the timber, but also the width of the boards and the way in which the edges of the boards are worked to form the joints. In this case he notices that some of the 7-inch flooring is not properly seasoned and has the appearance of being sappy. Such boards should be picked out and the contractor ordered to remove them from the site. It is most desirable to see that defective materials are removed from the site without delay, or otherwise there is the risk that they may be used in the work when the clerk of works is engaged on some other part of the building.

29. The clerk of works must see that the floor boards in the process of laying are clamped up close to one another, so that tight longitudinal joints are formed, and that the boards are well nailed to the joists, with the nails properly driven home and their heads punched into the boarding. He must also see that the oak mitred borders are provided as specified, and that a proper close finish is made by the floor boards against walls and partitions. When the wood-block floor in the scullery is being laid, the clerk of works must see that the concrete is finished to a perfectly smooth face to receive the wood blocks, and that the blocks are bedded on a thin layer of mastic asphalt, and the joints between them made in the same material. In this building the architect requires the blocks to be held together by hardwood keys or dowels, in order that the blocks will not work loose when subjected to the inevitable rough treatment of a scullery floor.

CONSTRUCTION AND FIXING OF WINDOWS

30. Character of Windows.—As is customary in present-day work, some window openings are fitted with casements and some with double-hung sashes. The character of the frames affects the method of fixing. Solid frames for casements are

usually fixed at the same time as the brickwork is constructed, as the frames are held by having their heads run into the brickwork. Cased frames for double-hung sashes are not fixed until the floors are laid. The inspection of the frames and sashes is, of course, also affected by the character of the joinery. In all cases the thickness of the parts must be measured. In this connection it should be noted that the sizes given in the specification are the commercial sizes out of which the members are cut. Allowance must therefore be made for planing, but this must be strictly reasonable, as the specification provides that pieces wrought on both sides are not to be more than $\frac{1}{8}$ inch less than the full specified dimension. In order that the clerk of works may keep in touch with the general construction of the joinery work, whenever possible, he should visit the contractor's workshops. If the joinery is not seen until it arrives on the building, the clerk of works will have difficulty in finding out whether it has, in all respects, been constructed in accordance with the specification.

31. Inspection of Casement Sashes and Frames.—In addition to checking the sizes of the casement sashes and frames, including the glazing bars, which are here specified to be 1 inch, the clerk of works should see that the framing has been properly put together, and should note that the sills are as specified. He should also compare the sections of the executed work with the detail drawings, in order to see that the throatings and grooves required to make the construction thoroughly waterproof have been provided. It will sometimes be found, where the details show methods not often met with in general practice, that the construction does not correspond with the drawings. When each frame is being fixed, the clerk of works should see that it is properly wedged to the opening and that the water bar invariably provided to make a waterproof joint between the wood and stone sills is properly set. As is customary, that portion of this bar which fits into a groove in the stone sill is to be set in cement, and that portion which fits into a groove in the wooden sill is to be set in white lead. It is necessary also to examine the butts with which the sashes are hung, to see that they are as

specified. Those casement sashes which are fixed are to be bedded in white lead and fixed with screws. The clerk of works may find that they are being nailed to the frames ; in that case, he must order the nails to be pulled out and the sashes fixed with screws as specified.

32. Inspection of Double-Hung Sashes and Frames.—When inspecting double-hung sashes and frames, the same care must be taken, as in the case of casements, to examine the form of the sills and the provision of a proper water bar under each wooden sill. The detail drawing shows that the frames are to be fixed so that the full width of the frame is exposed on the outside ; this is a growing practice. Most architects now desire to let at least a large proportion of each window frame show on the exterior of the building ; the joint between the edge of the brickwork jamb on the external face of the building is covered with a small wooden moulding. Before the frames and sashes are fixed, the clerk of works should check the sizes of the pulley stiles and linings, and other members that form the frame for a double-hung sash. Sometimes, instead of a continuous backing, diagonal strips are nailed across between the edges of the linings. If the strips are placed close together this construction is to be preferred to a continuous backing, as, in the latter case, there is a liability for the wood to be split by the nails, which must be driven in the same line of grain about $\frac{3}{8}$ inch from the edges. In cheap work, these strips are placed wide apart, but this construction is not to be recommended.

33. After examining the frames, the clerk of works should inspect the sashes, in order to see if they are the proper thickness and if the joint at the meeting rails has been formed as shown on the detail drawing. He should also examine the axle pulleys and lines. The frames, when got into position, are to be nailed to fixing bricks built in the jambs of the openings ; these bricks should be placed at vertical intervals of about 2 feet.

34. Fixing Sashes in Reveal.—When the method of placing frames in reveal with the rabbet of the brickwork on the inside face of the wall is adopted, it is very desirable to screed the

backs of the reveals as shown in Fig. 2. Wooden screeds *a*, about $4\frac{1}{2}$ inches by $\frac{3}{4}$ inch, are placed perfectly upright on the face of each reveal, but project about $\frac{3}{8}$ inch beyond the back of the reveal. They are kept in position by a wooden strut *b* driven between them. The spaces *c* thus left are filled in with lime-and-hair mortar, a straightedge the full width of the opening being used to bring the mortar to a true face. Then, when the cased frame is fixed, it butts tight against the prepared screed. Unless the backs of the reveals are screeded in this manner, the space between the frame and the brickwork must be filled with pointing, which is rarely satisfactory.

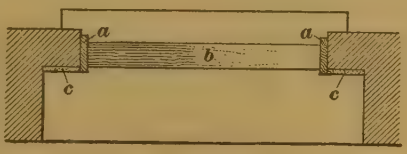

FIG. 2

35. Fixing of Grounds.—At this stage of the work on the building, the grounds are fixed by the carpenters. Grounds on the internal faces of brick walls should be nailed to the coke-breeze fixing bricks provided in the brickwork for this purpose. In cases where no fixing bricks are provided, the grounds must be nailed to plugs driven into the joints of the brickwork. Grounds must be provided round all window openings, door openings that are to be finished with jamb linings, and the bottom of all walls and partitions enclosing rooms that are to be finished with a wooden skirting. Also, where a picture moulding is to be provided, a ground must be fixed in order that this moulding may be properly secured; grounds and backings are also required for the panelling in the vestibule and the hall. Grounds are almost invariably splayed for the purpose of enabling a sound joint to be made with the plaster. The thickness of the grounds must be the same as the thickness of the plastering.

36. Superintendence of Glazing.—Window sashes are usually glazed at the glazier's shop, given one coat of paint in addition to the priming coat, and brought on to the building ready for hanging. They must therefore be examined by the clerk of works when he visits the contractor's workshops. The thickness

of the glass must be checked ; a very experienced man can do this, if it is sheet glass, by tapping it with the knuckles or feeling it with the finger and thumb ; the use of a gauge, however, is a more reliable method. The method of glazing must also be seen and care taken that the glass is properly back puttied ; that is, that a thick layer of putty is placed round the rabbet of the glazing bars before the glass is inserted. Then, before the putty is placed round the outside edges of the glass, the sprigs must be placed in position ; these should be placed about 9 inches apart, and in addition should always be placed about 2 inches from the corners. The sprigs are then covered by the outer layer of putty, which is finished with a splay all round the sheet of glass.

37. The method of glazing is shown in Fig. 3 (*a*) and (*b*). In (*a*) is shown an elevation of a pane of glass as seen from the outside of the building, where *a* represents the glass, *b* the portion of the glazing bars that shows in front elevation, and *c* the putty extending all round the frame. A section through one of the glazing bars is shown in (*b*). Here the portion of the glazing bar that is seen in front elevation is shown at *b* and the putty on the face of the glass at *c*. One of the sprigs is shown at *d* and the layer of putty at the back of the glass at *e* ; the glass itself is shown at *f*. This is the common method of glazing windows. The glass in doors is usually set in wash leather and fixed with movable beads, no putty being then required.

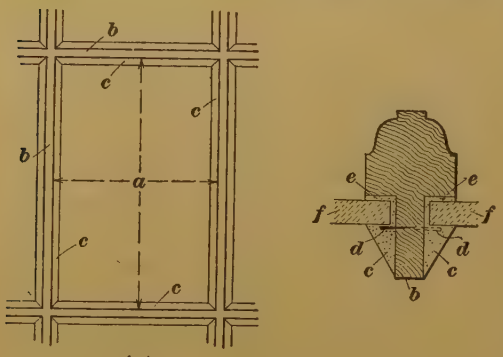

FIG. 3

38. Construction of Doors.—Although, with the possible exception of the external doors, no door will be hung until the plastering is finished, all the doors will by this time have been

completed except for the final wedging up, which will not be done until the doors are to be sent from the workshops to the building. While the construction of the doors, window frames, and sashes was in progress, the clerk of works should have visited the contractor's workshops in order to see that the work was being properly done. In the present instance he found the work to be going on satisfactorily, with the exception that the lock-rails of the $1\frac{3}{4}$-inch doors for the cupboards were framed to the stiles by means of a double tenon instead of the pair of double tenons that must be provided when a mortise lock is to be fixed. This mistake in construction was due to the fact that the specification was carelessly read and it was not noticed that these doors were to be fitted with mortise locks. New doors had therefore to be constructed and the other doors used in a position where only rim locks were to be provided.

SUPERINTENDENCE OF PLASTERING

PLASTERING MATERIALS

39. Commencement of Plastering. — The building has now reached the state when the plastering may be commenced. The carcase of the building has been completed for some time. The floor boards are down, the window frames and sashes are fixed in position, the framework of the stud partitions has been erected, and the solid door frames are fixed. The remaining joinery work, which consists of the construction of the staircase and panelling, the fixing of jamb linings, architraves, and skirtings, should not be done until the plastering is completed.

40. Mortar and Sand for Plastering.—The mortar for plastering is to be formed of freshly burnt greystone lime and clean sharp freshwater or pit sand. The coarse stuff is to be composed of 2 parts of sand to 1 of lime, with, in addition, 1 pound of bullocks' hair to every 3 cubic feet of the mixture of lime and sand. In the early stages of the building operations, the lime should have been slaked in order to comply with the requirement

that the lime shall be slaked, screened, and run into putty at least 2 months before it is to be used.

41. Preparation of Coarse Stuff.—It is a common practice for the lime to be slaked and mixed with the necessary sand and hair to form plasterers' coarse stuff in one operation. The amount of sand required for the amount of mortar to be mixed is formed into a large ring on a close-boarded mixing platform. A large tub is placed adjoining the ring of sand, together with a cistern and a plentiful supply of water. The measure of lime is then placed in the tub and covered with water. As the slaking proceeds more water is added, and the contents of the tub constantly stirred with a stiff piece of timber with a pointed end, until all the material is converted into a thin creamy solution. The plasterer's labourer usually knows by experience the probable amount of water required to effect the slaking, and arranges accordingly. A plasterer's sieve is then placed on two bearers overhanging the ring of sand, and the labourer pours pailful after pailful of the liquid lime, which is termed *putty*, into the sieve until the tub is empty. A certain amount of residue accumulates in the sieve, consisting principally of lumps of lime that will not slake. This is removed from time to time and the meshes of the sieve cleared.

42. The process is repeated if more than one tub of lime is required for the amount of mortar to be formed. The hair, which has been well beaten, is then added, and the whole collection of materials is turned over with a shovel, the sand being at first worked from the inside of the ring in order that the liquid lime may be stiffened by the addition of the sand before the ring is broken, or otherwise the lime will escape. The mass is then thoroughly mixed with a mortar larry or hair hook. It is then made up in a heap and kept ready for use. It is a common practice to mix the mortar several weeks before it is required.

43. Preparation of Fine Stuff.—The material used for the finishing coat in plaster is an admixture of plasterer's putty and fine washed sand, in the proportion of about 2 parts of sand to 1 of lime. As, however, some limes will take more sand than

others, the gauging must be determined by the nature of the lime. The putty is obtained, in a similar manner to that for coarse stuff, by *running* the putty, as the operation is termed, in a tub. The sand, however, is not added to the putty until the material is required for use ; therefore the putty, when it is passed through the sieve, is deposited in a built-up water-tight receptacle of rough boards, termed a *putty bin*. The top of the bin is covered over and the putty kept in it until it is required for use. The sieve used in this case is much finer than that used in the preparation of coarse stuff. The clerk of works should make sure that sufficient lime putty is run to enable the whole of the setting coat to be finished, for if a fresh lot of putty has to be run, the walls may get too dry to receive the setting coat properly.

44. Laths for Plastering.—The laths are specified to be riven fir laths of the kind known as lath-and-half ; these have a thickness of approximately $\frac{1}{4}$ inch. Laths are almost invariably specified to be riven, for if they are sawn it is probable that the fibres, which rarely run absolutely straight in ordinary wood, will be cut through, and the strength of the laths consequently reduced. Laths should be free from loose knots, sap, and waney edges, and should be properly seasoned. When the laths arrive on the building, shortly before the plastering is to be commenced, they should be examined by the clerk of works, who, in this case, finds that they are of fair quality. As he is not altogether satisfied with them, he calls the attention of the architect to them, who agrees that they are not exactly first class, but decides that they may be used.

45. Plastering of Walls and Brick Partitions.—In all good work the plaster is applied in three coats, termed, respectively, the *rendering*, or first coat ; the *floating*, or second coat ; and the *setting*, or finishing coat. In cheap work, it is a common practice, particularly in provincial districts, to apply only two coats, the thickness of the first coat being about the same as that of the combined thickness of the rendering and floating coats in three-coat work. In the present case, three coats are specified. The surfaces of walls and brick partitions that are

to receive plaster should be left as rough as possible in order that the plaster may obtain a good hold. As the bricks should have a rough and not a smooth and vitrified surface, second-quality bricks often form a better surface for plastering than first-quality bricks. Bricks with a keyed face to hold the plaster are often used. The first coat of the plastering is applied in an approximately even layer about $\frac{3}{8}$ inch in thickness over the whole surface of the walls of the room in which the plastering is commenced. The coat is then scratched over in order that the second coat may adhere firmly to it. The tool used in scratching consists of five or six laths nailed together at one end and fixed open fan-wise at the other end.

46. Screeds.—After the rendering coat has set hard, mortar screeds about $\frac{3}{8}$ inch in thickness are run along all margins and down the angles or corners. A long straightedge is applied, and the screeds are worked until a perfectly true surface is obtained; intermediate screeds are put in, especially on large surfaces, the number of course depending on the length of the straightedge. A careful workman will apply a bricklayer's plumb-rule to the straightedge, in order to get an absolutely vertical surface. After the screeds are sufficiently dry, the body of the floating coat is filled in and worked to the plane of the screeds. The screeds in all corners and on angles should be plumbed. In rooms having a plaster cornice, the mortar of the floating coat should be scored to a rough surface along the margin of the ceiling and side walls to afford a good key for the extra weight of plaster. Most architects consider that a hollow space at the back of the skirting is undesirable, and therefore require that the plaster shall be carried down to the floor level. In the very best work, the space at the back of the skirting on the ground floor is sometimes required to be filled with cement in order to prevent dry rot.

47. Plastering of Stud Partitions.—The process of plastering the surfaces of stud partitions is similar in all respects, after the lathing has been completed, to the execution of three-coat work on brickwork. Three coats are invariably used when plastering stud partitions, even though only two coats are used on the walls.

The laths should be spaced from $\frac{1}{4}$ inch to $\frac{3}{8}$ inch apart. If the laths are too near together, the mortar cannot be sufficiently pressed into the joints, and therefore will not obtain a good hold; while, if the laths are too far apart and the mortar is quite soft, the key will drop off from its own weight. Care should be taken to see that the laths are nailed to the studs at every point

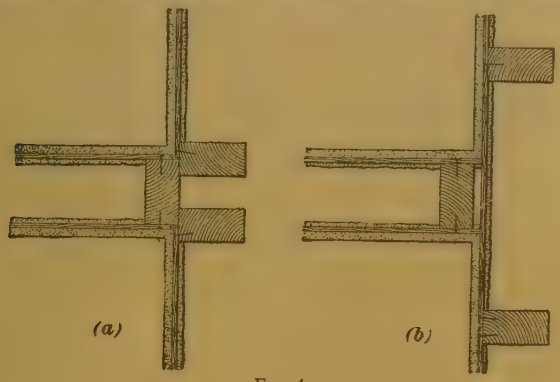

FIG. 4

of bearing, that no laths are allowed to fall short of the bearing at the ends, and that the studding is grouped at angles, as shown in Fig. 4 (*a*), thus giving proper nailing surface for lath ends on both partitions. Laths should never be allowed to run at the back of an abutting partition, as shown in (*b*).

48. The laths in the present case are specified to break joint in 2-foot lengths, a requirement that is inserted in order that there may be no risk of there being a continuous crack in the plaster, as might be the case if the end joints between the laths were all in one straight line. In this case, however, the clerk of works finds that this requirement is not being in all cases strictly complied with, the laths being in some instances carried along for a distance of 3 feet before they are made to break joint. He therefore calls the attention of the workmen to this fact, and states that if this requirement is broken in the future all the studding must be stripped and the lathing re-executed. When the first coat of plaster is applied to a lathed surface, sufficient force must be used to squeeze the mortar through the joints between the laths so that a good key is obtained. After the

first coat has been applied, screeds are formed and the second or floating coat applied in the ordinary way.

49. Setting, or Finishing, Coat.—The thickness of the finishing coat is not more than $\frac{1}{8}$ inch. When applying the finishing coat, a good workman will take great care that all his tools and the mortar board are perfectly clean ; sometimes, a careless man will use a rusty trowel, or perhaps his labourer, in filling his hod, will use a shovel that has been employed for some other purpose. The clerk of works should follow this work carefully to see that the plaster is applied in a thoroughly even surface over the floating coat. He should also see that no iron nails or other metal work that are apt to rust are left in a position to discolour the plaster, as the setting coat should show a perfectly smooth and unblemished surface at completion. All cornices must be run before the setting coat is applied, or the finish is likely to be damaged.

50. Finishing of Angles.—The external angles of chimney breasts and other projections are liable, if finished in ordinary plaster, to be knocked off. It is also difficult to form a perfectly straight and true angle in ordinary plaster. Therefore it is customary to use a special material at these points. It is specified in the present case that all angles in the plaster are to be run in Keene's cement on a Portland-cement backing, and that all salient angles are to be slightly rounded. The clerk of works may find, however, that the Portland-cement backing is being omitted and only a thin fillet of Keene's cement applied on top of the ordinary plaster. As this forms a very poor job, he should direct that all angles so run be cut away, and the work re-executed with a proper Portland-cement backing, and that in the running of all the angles the requirements of the specification be complied with.

51. Plastering of Ceilings.—The ceilings and the soffits of the stairs are plastered in exactly the same way as the stud partitions. The laths, in the case of the ceilings, are nailed to the under side of the floor joists, or, in the attic, to the under side of the roof timbers ; in the case of the stairs, they are nailed to

the under side of the rough carriages and the edges of the strings. Where partitions occur running parallel with the floor joists, a nailing space at their heads for laths should be provided, either by spacing the joists as shown in Fig. 5 (*a*), or by placing a continuous piece between the joists, secured by cross-pieces at

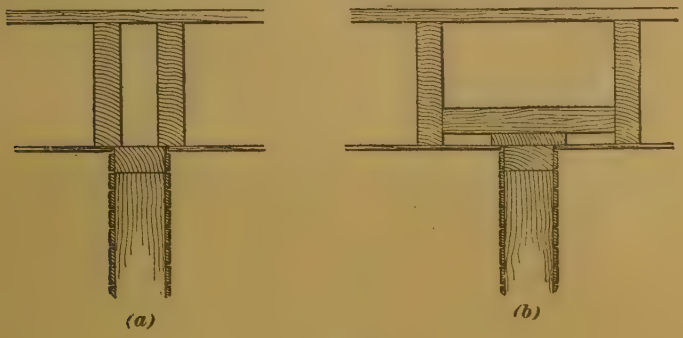

FIG. 5

intervals extending from joist to joist, as shown in (*b*). These precautions are required in order that the laths holding the plaster may be well secured. If the laths are loosely fastened, the plaster will be liable to crack and fall off in course of time.

52. Scotch Practice in Plastering Walls.—Throughout practically the whole of Scotland, and in many districts in the North of England, it is the rule to *strap*, as it is termed, the sides of all walls and brick partitions before the plastering is applied. This strapping consists of spiking vertical battens at intervals of about 15 inches to the sides of the walls from floor to ceiling. These are then lathed on the inside face and plaster is applied as to the side of a stud partition. One of the reasons for this practice is that in these northern districts comparatively soft and absorbent local stone is used as a walling material, and unless the walls are battened and lathed on the inside they may prove to be damp.

53. Brandering of Ceilings. — Instead of nailing the laths direct to the under side of the joists for the ceiling, it is a common custom in Scotland and the North of England to brander the

under side of the joists. This consists in nailing wooden strips about 15 inches apart at right angles to the joists, the laths being then nailed to these strips. One of the reasons for this practice is that, for the most part, the joists used are thicker than those customary in the midland and southern portions of England, and when a joist is thicker than about 2 inches it is difficult to obtain a good key to the plastering under each joist unless some arrangement of brandering or of counterlathing is adopted.

54. Running of Cornices.—None of the cornices in this building are of great girth, and consequently they are all specified to be formed on a rough plaster backing. The clerk of works should see that the zinc profiles for running the cornices are exact copies of the sections supplied by the architect, and that in the execution of the work all mitres, stops, and returned ends are finished in a satisfactory manner. He should devote particular attention to the cornices of the dining-room and hall, the first of which has a $1\frac{3}{4}$-inch enrichment, while the second is finished with modillions. He may find that the workmen are inclined to execute this special work in rather a slipshod manner, but by speaking to the contractor and informing him that if the work is not carried out more satisfactorily it must be re-executed, he should be able to obtain a great improvement in the character of the workmanship.

55. Wood Bracketing for Cornices.—As the thickness of the rough plaster backing to a cornice should not be more than about 2 inches, in the case of large cornices it is necessary to provide wooden bracketing. In Fig. 6 (*a*) is shown an example of bracketing *a* for a cornice to a stud partition at its junction with a brandered ceiling. The method of setting out this construction is as follows: A strip *b* is first nailed along the floor joists above and the brackets are fastened to it, they being in this way kept in a straight line; a cord stretched across the studs is sufficient to bring the bottom of the brackets into alinement. If no furring strips *c* are to be used on the ceiling, the brackets are notched over this strip *b*, as shown in (*b*), or the strip may be omitted entirely. The rough brackets *a* should be shaped so that the plaster is not thicker than 1 inch at any

point, except on acute angles and similar positions, where a slightly increased thickness is unavoidable.

56. Drying of Plaster.—Where walls are to be finished with distemper, it is very desirable that the plaster is dry before the distemper is applied. In cases where walls are to be papered, there must be no dampness in the plaster, for the paper will be discoloured and liable to fall from the walls. If time permits, and the work is carried out in the spring or summer, the plaster

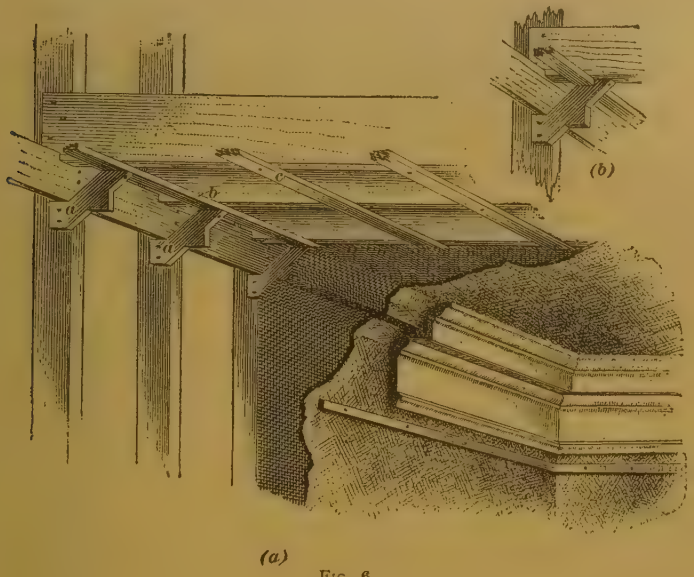

FIG. 6

may be dried by opening all the windows and providing a through circulation of air. When there is not time for this or when the weather is too damp to enable the drying to be completed in this manner, the fires may be lighted. If by any chance the stoves have not arrived, fire-pots of charcoal may be placed in the centre of each room. The plaster walls of new buildings should not be papered for the first year, in order that the plaster may thoroughly dry out. Often, when dwelling houses are to be occupied soon after their completion, the walls are distempered.

COMPLETION OF JOINERY AND OTHER FINISHINGS

CONSTRUCTION OF STAIRCASE

57. Construction of Staircase Well.—When the plastering is completed, the remainder of the joinery work may be completed. When the work to the floors was in progress, the floor timbers were trimmed in order to leave a space for the staircase, termed the *staircase well.* The size of this space was then checked by the clerk of works and found to be correct. It is very necessary to check the size of the space allowed in trimming for a staircase, as even a slight inaccuracy in setting out may result in a diminished headroom, which may be a very serious matter when the headroom proposed in the first instance to be allowed is the minimum consistent with good planning. It is a very common custom not to complete the trimming until the staircase is properly set out, thereby avoiding the risk of error.

58. Setting Out Staircases.—Stair building is about the most difficult operation in joinery work, and it is practically always entrusted to men who have had special experience in this class of work. When setting out a staircase, the only measurements that should be taken from the drawing are the length of the

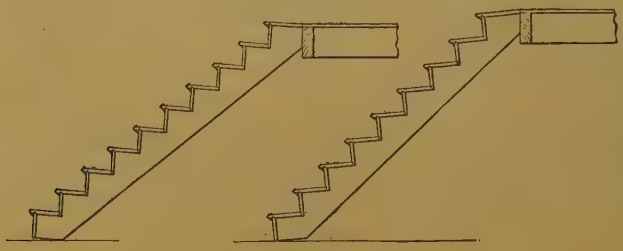

FIG. 7

stairs and the height from floor to floor; and no absolute reliance should be placed on the drawing, as these measurements are carefully checked on the building. The foreman or special staircase hand in charge of the work, having ascertained by measurement the height from floor to floor, should measure off

this height on a rod and divide it into spaces corresponding in number with the risers in the staircase. If the measurements given on the drawing for the height of stories are trusted and not checked, and the stringers are cut to fit the height thus taken, a staircase resembling those shown in Fig. 7 may result.

It is very important in setting out stairs to have all risers of a uniform height, for any change in height, although not apparent to the eye, will be discovered by travelling up or down. If in a staircase having two flights, with a landing between, the risers of the upper flight are $\frac{1}{2}$ inch higher than those below, a person ascending this staircase rapidly will be checked, as it were, as soon as the higher risers are reached, and will be likely to trip.

59. Superintendence of Construction of Staircase.—The greater part of the construction of the staircase is done in the contractor's workshops, so that it is practically only the fixing that must be done on the building. On the arrival of the staircase, the clerk of works should check the sizes of the strings, treads, risers, newels, and other parts to see that they are correct. When the fixing of the staircase is commenced, he should see that the treads and risers are properly wedged up at the ends, where they are housed into the wall string, and that the mitring of the other end of each riser with the cut outer string is properly carried out. In this case, on examining carriages beneath the stairs, the clerk of works finds that the treads are merely allowed to rest on the carriages and are not bracketed to the carriages as required by the specification. He consequently orders stiff bracketing pieces to be forced hard up against the under side of the treads and then soundly spiked to the carriages.

When the newels and balusters are being fixed, the clerk of works must see that the newels are exactly vertical and that the balusters are properly housed to the treads and to the hand rail. He must also see that the hand rail is properly constructed with the ramps, as shown on the detail drawing, and that all the joints between the several lengths of mahogany forming the hand rail are soundly made with hand-rail screws. On the completion of the staircase, the workmen should protect the treads with thin pieces of board.

CONSTRUCTION OF PANELLING

60. Superintendence of Vestibule Framing.—When the carpenters have practically completed their work in the rest of the building, the contractor may have them fix the studwork of the vestibule framing. Then, when this is completed and the general joinery work cannot be proceeded with until the plastering is completed, the panelling, which forms the interior finish, is commenced. In this case the clerk of works, when examining the wood used for the panelling, finds that one or two lengths are split at the edges; he therefore directs that they shall not be used. He then looks after the execution of the work and sees that the panelling is properly secured with screws to the $\frac{3}{4}$-inch rough backing, and that it is properly returned at the jambs of the window and window recess.

61. Superintendence of Hall Panelling.—The specification requires that 1-inch panelled framing is to be fixed round the hall, with a $5'' \times 2''$ pilaster placed on each side of the staircase opening. The clerk of works should examine the wood for panelling, and should find it to be satisfactory if it is free from the defects noted in the case of the wood used for the vestibule framing. When the panelling is being fixed, he should see that it is properly secured by screws to the $\frac{3}{4}$-inch rough backing and that the panelling is properly finished against the casing of the ceiling beam. In order to minimize the risk of dry rot in this building, the clerk of works requires the back of the panelling next the wall to be painted one coat of good priming colour. The clerk of works must also pay attention to the details of construction, and must see that the capping provided is mitred round the pilasters and a square plinth provided to each pilaster as specified.

62. Panelling to Dining-Room Fireplace.—Before the panelling round the recessed fireplace in the dining-room is commenced, it is necessary for the register to be set. By this time the kitchen range and registers should have been selected by the architect, delivered to the building, and checked by the clerk of works. The clerk of works should see that in the setting of the register

the spaces between the firebrick backing of the register and the inside of the chimney jambs are filled solid with fine concrete, and that the register is in all respects set solidly in between the brick jambs without any hollows or crevices being left.

MISCELLANEOUS JOINERY WORK

63. Fixing of Jamb Linings.—Nearly all the internal doors on the ground floor and all the doors on the upper floors of this house are specified to be hung in linings. The width of the linings depends on the thickness of the wall or partition in which the opening to which the linings are provided is made. The thickness considered is, of course, the full thickness of the wall or partition, including the thickness of the plaster on either side. It is a safe plan to take accurate measurements for the width of the linings after the grounds are fixed in position. Details showing the construction of jamb linings to an opening in a 9-inch wall, an opening in a $\frac{1}{2}$-brick partition, and an opening in a stud partition are supplied by the architect. The linings to the openings in the 9-inch walls are shown to be framed up, for if they were made out of single pieces of stuff of the required width, about $10\frac{1}{2}$ inches, they would almost certainly warp and split. These drawings should be worked to by the joiners in the contractor's workshops, and the linings should come to the building ready to be fixed. The clerk of works should check the sizes and thicknesses of the linings so as to see if they are correct. In the present instance, however, he finds that when the first jamb linings are being fixed there are only three backings provided to each jamb. Since, however, a note on the detail says that the backings are not to be more than 1 foot 9 inches apart, he must require the joiners to provide four backings to each jamb, for, if only three backings are provided, they will come more than the specified distance apart.

64. The clerk of works also notices that although $1\frac{1}{2}$-inch twice-rabbeted linings are specified for the openings on the first floor, the linings proposed to be fixed are 1 inch in thickness with a $\frac{1}{2}$-inch stop nailed on. He informs the contractor that

linings of this kind must not be used on the first floor, but only in the attic, where such construction is specified. The forming of the necessary rabbet for the door in a jamb lining by nailing on a stop is a common form of construction in cheap work and a necessary arrangement in the case of skeleton jamb linings; but, as there is a danger that the stop may be slightly split during the course of fixing, and may therefore tend to become detached, a lining of this kind is not so good as a rabbeted lining, and should not be allowed to be used when a rabbeted lining is specified. It is to be noted that in all good work the linings are tongued together at the angles.

65. Fixing of Window Linings and Window Boards.—The linings to the windows are fixed in a very similar manner to the jamb linings. They are tongued together at the top angles, tongued to the window board at the bottom, and nailed to the fixing bricks built into the jambs of the opening. Window boards are fixed to fixing bricks built into the brickwork below the sill level and are, in addition, always tongued to the wooden sill. Window boards are best held to the ends of the fixing bricks through a moulded fillet tongued and glued to the end of the board.

66. Fixing of Skirtings.—Skirtings are fixed to vertical backings previously provided, which are spaced about 2 feet apart. The bottom of a skirting must be accurately fitted, or, as it is termed, *scribed*, to the floor, and the skirting ground should have been arranged so that the skirting when fixed extends slightly above it. The external angles of a skirting are mitred together, and also glued in the case of short lengths. The internal angles are grooved and tongued in the plain portion of the skirting, but the moulded portion is merely scribed. The detail drawings show that plinth blocks are to be provided at the door jambs. These are usually adopted in order to form a base for the architraves and a stop for the skirting. A plinth block is usually 2 inches higher than the skirting and $\frac{1}{2}$ inch wider and $\frac{1}{4}$ inch thicker than the architrave, and the face is bevelled to suit the architrave. Plinth blocks are fitted over the skirting, which is extended a little distance for this purpose.

In very good work, the architraves are dovetailed into the backs of the plinth blocks.

67. Fixing of Architraves and Picture Rails.—When all linings and skirtings are in position, the architraves may be fixed; these are properly mitred at the angles. The picture rails are the final joinery finishings to be fixed. When going over the building and generally examining the work, the clerk of works in this building finds that no picture rail is fixed as specified in the morning-room. The reason for this is found to be that the directions given by the contractor to the joiners were to fix a picture rail in each room where a ground for this purpose had been provided, and in the morning-room the ground for the picture rail had been so covered by the setting coat of plaster that it was barely visible. A picture rail is of course directed to be fixed in this room. When casings for pipes are required, grounds for fixing purposes should be provided before the plastering is executed. The cover board for such a casing should be fixed with brass cups and screws.

68. Hanging of Doors.—The building is now so nearly completed that there is nothing to prevent the doors from being hung. The clerk of works must see that they are hung so as to swing in the manner shown on the drawings. He should never on his own responsibility require a door to be fixed so as to swing in a different manner from that shown on the drawings; but if it seems to him that a door is obviously shown to be hung from the wrong stile, he should raise the point with the architect, for possibly there is an error in the drawings which has escaped his attention. The clerk of works must see that the doors are hung on butts of the size and character specified; and in this case he must see that while the other doors are hung on a pair of butts, the front entrance door is hung as specified on $1\frac{1}{2}$ pairs, that is, on three hinges. All heavy doors should be hung on $1\frac{1}{2}$ pairs of butts. The provision of the third hinge results in a very strong connection between the stile of the door and the lining or frame, and prevents that strain on the framing of the door which occurs when a heavy door is hung on two hinges only. Doors should be hung sufficiently high to clear the carpets.

69. Cupboard Framing, Shelving, Etc.—The construction of the kitchen dresser and the various details of cupboard framing and shelving may now be commenced. This work, however, may be carried on at the convenience of the contractor, and, if there is a good deal of other work to be done and the specified time for the completion of the building has not yet approached, no objection can be raised to this arrangement. The clerk of works must, however, watch that no such joinery work can at any time be fixed without its erection being supervised by him. When any joinery fittings of this kind arrive at the building, the clerk of works should examine the material and check its thickness, and generally should measure the work to see that it is constructed in accordance with the drawings. Then, when the fittings are passed as satisfactory, he should examine the fixing and see that the workmanship throughout is of a sound and reliable character.

FIXING OF STOVES

70. Setting of Kitchen Range.—The range for the kitchen should, by this time, have been selected by the architect, delivered on the building, and checked by the clerk of works. As the plastering has been completed, the setting of all stoves can be proceeded with. Before the kitchen range is set in place, the clerk of works should very carefully examine it in order that he may be perfectly familiar with the arrangement of flues and dampers. The detailed arrangement of each type of kitchen range varies to some extent, so that, unless the clerk of works makes himself thoroughly acquainted with the peculiar features of the type of range that has been selected, he will not be able properly to superintend its setting. When the range is being set, the clerk of works should see that all spaces at the back are filled solidly with concrete and that the flues are soundly constructed and properly connected to the chimney flue. As the efficiency of a range is dependent to a very great extent on the manner in which the range is set, very close supervision of this work is required. The setting of the range cannot be completed until the hot-water fitter has made his connections with the boiler.

The chief point to be here considered, when setting the scullery copper, is the construction of the flue. This should be built so as to curl corkscrew fashion round the copper, for by this means the heat of the copper fire is utilized to the fullest extent.

71. Setting Register Stoves.—When the work in the kitchen and scullery is completed, the setting of the various register stoves is commenced. These stoves having been selected by the architect, he should instruct the clerk of works as to the room in which each stove is to be fixed. As soon as the bricklayers are ready to set these stoves, the clerk of works should superintend the allocation of the stoves to the several rooms, so that there may be no risk of a stove being fixed in a wrong room. He must then superintend the setting of the stoves, and see that the necessary holding-in cramps are provided, that the stoves are properly backed up in concrete, and that the work at the junction of each stove to the chimney flue above is executed in a careful manner.

72. Fixing of Mantels and Bedding of Hearths.—Wooden mantels are specified to be provided in the kitchen, drawing-room, and morning-room. The mantelshelf in the kitchen consists of a $1\frac{3}{4}$-inch board, with rounded arrises and corners, carried on two plain brackets. In order to prevent the possible warping of a wooden mantelshelf, sometimes a length of $\frac{1}{2}$-inch gas piping is run through the shelf at either end. Each piece of gas piping is made to extend to within $\frac{1}{2}$ inch of the front edge and project 4 inches at the back; this projecting portion is built into the brickwork. The mantels for the two chief rooms are of more elaborate pattern and are selected by the architect from the stock of a specialist firm. The clerk of works should inspect these mantels on delivery to see that they are in good condition and have not suffered damage in transit. He should then, having been previously instructed by the architect, direct which mantel is to be fixed in the drawing-room and which in the morning-room, and should see that the mantels are soundly secured to coke-breeze fixing blocks that were built into the wall for this purpose. The mantel in the dining-room was constructed when the panelling to the fireplace was executed. All

the mantels to the other fireplaces are of iron and are fixed at the same time as the stoves.

73. The plasterers are now able to set the tile hearths, the tiles for this work having been supplied together with the stoves. The clerk of works, when inspecting the hearths in this building, finds that one of them is badly set, the tiles being very uneven. This he directs to be relaid, and informs the contractor that any tiles that may be broken in the course of the re-execution of this work must be replaced by him at his own expense.

SANITARY WORK AND WATER SUPPLY

SANITARY WORK

INSPECTION OF FITTINGS

74. **Commencement of Sanitary Work.**—The internal sanitary work may be commenced at any time after the completion of the plastering. In ordinary cases, this work will proceed at the same time as the completion of the joinery finishings and the setting of the stoves. All the external drainage work was completed in the early stages of the erection of the building. The duty of the clerk of works, as regards the sanitary work, is to inspect the fittings on their arrival and see that they are in good order and in accordance with the specification, to superintend the fixing of the fittings and all pipes in connection with them, and to see that all the joints are formed in the soundest possible manner.

75. **Water-Closet Apparatus.**—Prime-cost sums are usually allowed in the specification for the water-closet apparatus, and it is provided that these fittings are to be selected by the architect. When the architect has done this, he gives the clerk of works a list of the fittings and, for the purposes of identification, the trade names given them by the manufacturers. When the fittings arrive on the site, the clerk of works should check them

off on the invoice supplied to the contractor, and then check the invoice by the list that he has received from the architect. He should then examine the fittings to see that they are in good condition, paying particular attention to the glazing of the pans and traps and to the general details of the water-waste preventers.

76. Bath and Lavatory Fittings.—Prime-cost sums are also allowed for the bath and lavatory fittings, and consequently the same procedure must be followed. In this case the clerk of works notices that the lavatory basin does not arrive at the same time as the bath, and that when it does arrive no invoice is forthcoming. He calls the attention of the architect to the matter, who, after examining the fitting, states that it is not the one selected, but one of a much inferior type. The contractor admits that the fitting is not the type selected by the architect, but states that such fitting is not procurable, being out of stock. An inquiry at the manufacturer's confirms this statement; therefore the architect chooses another good-class fitting of a different type.

FIXING OF FITTINGS AND PIPES

77. Fixing of Water-Closet Apparatus.—A lead tray must be provided under each water-closet apparatus. The object of this tray, or **lead safe**, as it is sometimes termed, is to prevent any water that may be accidentally spilt, or that may escape from the trap in the event of leakage, from penetrating the floor, rotting the floor boards, and injuring the ceiling of the room beneath. Where the floors are of concrete and are finished on the upper surface with tiles, lead trays are not required. After the lead tray has been fixed, the clerk of works must see that a 1½-inch lead waste is connected to the tray, carried through the wall, and finished with a brass flap as required by the specification. The fixing of the apparatus itself should be closely superintended by the clerk of works. He should see that the water-waste preventer is properly carried by cast-iron brackets fixed to the wall and that the earthenware pan is secured to the floor by stout brass screws bedded in red lead, and that the flush pipe is fixed to the wall in the manner specified. In this case, in the house closets the

flush pipe is fastened with brass clips and in the servants' closet with lead tacks.

78. Particular attention must of course be given to the forming of the joints. These are three in number. By far the most important joint is that between the outgo of the trap and the branch to the drain or soil pipe. In the case of the ground-floor water-closets, where the joint may be made to the drain, a simple cement joint is all that is required. In the case of the first-floor water-closet, where the connection is required to be made to the cast-iron branch of the soil pipe, a special flanged cast-iron connecting piece must be used. The flanged portion of this connecting piece fits over the outgo of the trap, the joint here being made in cement, and the other end of the connection fits into the socket of the cast-iron branch, the joint at this end being made in caulked lead. The joint connecting the top of the flush pipe to the outgo of the water-waste preventer should be a proper lead-wiped joint, and the joint at the other end connecting the flush pipe to the flushing rim of the pan is usually made by means of a connecting piece of india-rubber, termed an india-rubber cone.

79. **Overflows to Water-Waste Preventers.**—When inspecting the water-closet fittings after they are assumed to have been completely fixed, with the exception of the supply pipes to the water-waste preventers, which must necessarily await the installation of the cold-water supply, the clerk of works notices that no overflow pipe has been fitted to the water-waste preventer of the first-floor closet. If this omission had not been detected, it is probable that when the house was occupied the wallpaper and decorations of the ground floor might have suffered serious injury; for if, as sometimes happens, the ball valve does not act properly so as to cut off the supply, and there is no overflow pipe carried out to the external air, the percolation of water into the story below is likely to result.

80. **Fixing of Bath, Lavatory Fittings, and Sinks.**—In the fixing of the bath, it is necessary to provide a lead tray with a $1\frac{1}{2}$-inch lead waste, similar to the trays with accompanying wastes provided under the water-closet apparatus. The bath

and the lavatory fittings are to be fitted with hot- and cold-water valves, and the clerk of works should see that these are properly fitted on and that the connections between the outgoes of the bath and lavatory and the lead wastes are soundly made by means of wiped joints. He should also see that the lead wastes are not of less than the minimum weight specified for wastes, and that the wastes for the sinks and lavatory are supplied with lead traps. The trap for the bath is usually contained in the fitting itself. When fixing the sinks, a perforated brass grid must be supplied to the scullery sink, while the pantry sink, which is constructed of $1\frac{1}{4}$-inch wrought deal, is specified to be lined with 5-pound lead, with wide soldered joints at the angles. The formation of the lead joints and general finishings to this latter sink should be closely watched by the clerk of works, who in this building requires the copper nails holding down the lead, which is turned over the top edge of the sink, to be spaced much closer together than in the work first executed by the plumber. When close copper nailing is specified, the nails should not be spaced farther apart than 2 inches.

81. Fixing and Jointing of Soil and Vent Pipes.—The soil and ventilating pipes are specified to be of cast iron of not less weight than 54 pounds per 6-foot length. They are, of course, to be jointed in lead, and are to be fixed by means of wrought-iron straps bolted round them and built into the wall. The pipes are to be coated with Dr. Angus Smith's solution. The clerk of works must inspect the cast-iron pipes to see that they are properly coated, and should strike them with a hammer in order to make sure that they are sound and free from defects. He should also take care to see that the weight is not less than the minimum allowed.

When the fixing of the pipes is commenced, he should see that the straps by which they are held are solidly built into the wall and the brickwork round them built up and pointed in cement. When the ventilating pipes are carried up the requisite height, he notices that each pipe is finished at the end with a galvanized-iron wire cover. The specification, however, requires that

copper-wire covers are to be provided, and therefore the clerk of works directs that the galvanized-iron wire covers are to be replaced by covers of copper wire, these, of course, being of superior quality.

The connection of the soil pipe to the stoneware drain is in this case made in cement in a similar manner to the joint between two stoneware pipes. It is only when the soil pipe is of lead that it is necessary to use a brass or copper ferrule at the junction of the pipe with the drain.

WATER SUPPLY

COLD-WATER SUPPLY

82. Inspection of Materials.—The pipes for the cold-water supply are specified to be hydraulic-drawn lead pipes of not less than the weights per yard run given in a table in the specification. It is to be noted that the weights in this table are very much more than the weights in the table relating to waste pipes. Before the cold-water supply is laid, the clerk of works should examine the lead piping to see that it is of sound quality and of equal substance throughout; he should also test the weight and examine the fittings, paying particular attention to the $\frac{3}{4}$-inch screw-down gunmetal bib-cocks specified for the water-supply branches to the copper and the scullery and pantry sinks.

83. Provision of Service Pipes and Fittings.—When the cold-water supply is being laid, the principal points to be looked after by the clerk of works are the connection to the company's main, the sizes of the delivery and supply pipes, the provision of a cistern with proper fittings, and the fixing of the stop-cock, draw-off cock, and the various bib-cocks. The connection with the main is usually made with a $\frac{1}{2}$-inch screw ferrule and stop-cock by the water company's men. In this house, he must see that a proper connection is made with the cistern in the roof, that a screw-down full-way stop-cock is provided in the basement, that a draw-off cock is provided next the stop-cock, and that the bib-cocks are properly fitted to the ends of the several

branches. He must also see that a lead tray is provided under the cistern, and that the connections of the piping with the cistern are properly made. The contractor has endeavoured, where possible, to leave openings in the walls and partitions for the pipes so as to avoid cutting into the work. The pipes are fixed to the walls and partitions with wrought-iron clips. When the work is completed the clerk of works should try all the water-supply fittings, one by one, to see if they are in satisfactory working order.

HOT-WATER SUPPLY

84. Hot-Water Tank, Piping, and Fittings.—The pipes for the hot-water supply are, as usual, galvanized wrought-iron welded steam tubing. The piping is to be carried from the outgo of the range boiler to a 50-gallon galvanized-iron hot-water tank that is to be provided in the linen cupboard, the necessary supplies being then branched from this flow pipe. The object of placing the hot-water tank in this position is that the most efficient hot-water supply will be obtained by placing the tank on the first floor, and, further, that if placed in the linen cupboard it will keep the cupboard permanently dry and warm. The clerk of works must see that the tank provided is the size specified, that the joints between the lengths of pipe are proper screwed joints made waterproof by the use of red-lead cement, and that the connections to the range boiler and to the hot-water tank are made in a correct manner. He must also examine the hot-water screw-down valves provided at each sink, to see whether they are of a satisfactory pattern. When the work is completed, notice must be given to the water company's inspector, who will examine and pass on the work.

85. Hot-Water Heating.—In large buildings it is necessary to adopt some other method of heating than by open fires, and in the majority of cases the low-pressure hot-water system will be adopted. The supervision of this work by the clerk of works is a very responsible and by no means easy task. The work in practically every case will be carried out by a specialist, so that the clerk of works will be in the awkward position of being

required to supervise the work of men who know much more about the subject than he does. By the exercise of caution and common sense, he may, however, be able to render good service to the building owner. Should he notice that any portion of the work is being carried out in a manner that appears to him to be unsound, he should at once draw the architect's attention to the matter. The architect will then bring his experience to bear on the subject, and even if he is not able to decide of his own knowledge, he will be able to obtain expert opinion as to whether the work is being satisfactorily carried out.

GAS-FITTING, IRONMONGERY, AND PAINTING

GAS-FITTING

86. Materials and Fittings.—The gas pipes are specified to be wrought-iron welded tubing with the joints screwed in red lead. The pipes are to be fixed with a fall to the meter where possible ; where not possible, a small drip pipe and cock are to be placed at the lowest point to draw off any liquid that may accumulate. A prime-cost sum is allowed for the fittings, which are to be selected by the architect. When this selection has been made, the architect should give a list of the fittings to the clerk of works, so that the latter may check the fittings when they arrive on the site. When doing this in the present instance, the clerk of works finds that although the fittings are of the several types selected by the architect, two of the fittings are unsatisfactory. One appears to have been damaged at the manufacturer's and then repaired in a rather clumsy fashion ; the other has apparently been broken in transit. He therefore directs that these two fittings are not to be used, and the contractor returns them to the makers so that they may be replaced by sound fittings.

87. Fixing of Gas Pipes.—When finishing the brickwork of the internal walls and partitions and when boarding the floors, the contractor left spaces for the gas pipes, where possible, in

order that it might not be necessary to cut into the finished work. The clerk of works should superintend the forming of the connection to the gas company's mains, and the fixing of the meter inside the building. He should see that a $1\frac{1}{2}$-inch brass stop-cock and key are provided on the piping immediately adjoining the outgo of the meter, and that in the fixing of the horizontal distributing pipes the joists of the floors are not damaged. Throughout the work he must check the sizes of the pipes, to see that they are in accordance with the specification, and must see that the fixing of the pipes is, as required by the specification, by means of hooks to the walls and iron bands to the woodwork.

88. Fixing of Gas-Fittings.—When the distributing pipes are all fixed the fittings are put in place. In the principal rooms on the ground floors, the fittings are in the form of pendants suspended from the ceiling ; in the remaining rooms and in the bedrooms, wall brackets are used. The fixing of the fittings should be closely watched by the clerk of works, for this work is often indifferently done, with the result that there is leakage at the fittings almost as soon as the building is occupied.

89. Testing of System.—The specification requires that before any of the gas piping is covered, the whole system is to be tested to a pressure equal to 5 times that existing in the company's mains. The pressure in the mains may be found by inquiring at the office of the company. The architect of course should be present during the test. In the present case, when the specified pressure was applied, leakage occurred at one or two fittings, but otherwise the system appeared to be sound. The fixing of these fittings having been minutely examined and the faults remedied as far as possible, the test is again applied, when there is no appreciable leakage at any point ; the system is then accepted by the architect.

90. Supervision of Electric Lighting.—When, as is becoming more and more the custom in town houses, fittings for electric lighting are installed, the architect will not often be able to entrust the supervision of this work solely to the clerk of works. If proper supervision is to be obtained, the services of a person having a special knowledge of the details of electrical work will

be necessary; but, except in works of great magnitude, it will not be financially possible to have such a man on the premises throughout the whole of the time that the electrical supply is being installed and the fittings fixed. In ordinary cases, the clerk of works may be entrusted generally to look after the questions of materials and workmanship so far as he is able. Then, when the work is completed, a qualified electrician should be engaged to examine and test the system. The contractor should be required by the specification to allow the electrician's fee for the testing of the system in his tender, but the appointment of the electrician must rest with the architect.

SUPERINTENDENCE OF IRONMONGERY

INSPECTION AND FIXING OF IRONMONGERY

91. Final Stages of Work.—When all works relating to sanitation, heating, and lighting have been completed, the only remaining work is that of fixing the ironmongery and executing the painting. These operations must be very carefully supervised; the character of the finish to the ironmongery and painting is apparent to the most casual observer. Therefore, it is to the interest of all persons concerned in the erection of a building that at least no lower standard of workmanship should be adopted in relation to this work than that which has been hitherto employed. The architect must often be consulted regarding the suitability of the ironmongery and the general finish of the painting. He will probably exercise a more close supervision than when the structural work was proceeding, for since no questions of good taste or architectural appearance were involved, most matters of detail could then be safely left to be settled by the clerk of works.

92. Door Fittings.—The clerk of works should look over all the door fittings before he allows any of them to be fixed. The prime cost of nearly all these is specified, and the principal fittings are selected by the architect. As regards the less important fittings, the architect should instruct the clerk of works to

look over them, and then to have them laid aside for his inspection and approval. The clerk of works must check those fittings that have been selected by the architect from a list that has been given him, and should then examine the other fittings, one by one, making notes as to any special points, both favourable and unfavourable. When the architect next arrives at the building he should examine these fittings with the clerk of works, who should point out the special features that he noted in his inspection.

When the $5\frac{1}{2}$-inch mortise locks provided for the bedroom doors on the first floor of this house are being inspected, the clerk of works points out that the action of this type of lock seems weak and that in time the lock will cause trouble. The architect concurs with this view and directs that another type of lock shall be submitted. This is subsequently done and the type meets with his approval.

93. Window Fittings.—The butts on which the doors and casement sashes are hung, and the weights and axle pulleys for the double-hung sashes, should be inspected before these items of the joinery are fixed in position. The fasteners for the sash windows and the cockspur fasteners and stay-bars for the casement sashes are usually specified as prime-cost items. When they arrive on the building they should be checked from the invoice, as regards their cost, by the clerk of works. He should then carefully examine them to see if they are in a satisfactory condition.

94. Fixing of Ironmongery.—When the ironmongery is being fixed, the clerk of works should see that it is all soundly secured to the joinery in the best possible manner. Before finally passing the work, he should make a general tour round the building and test each fitting. In the present instance, the clerk of works must see that the ornamental brass features specified for the doors on the ground story are properly fixed after the manner shown on the detail drawing of the vestibule door. On examining the first-floor doors after the fittings have been fixed, he finds that the finger plates on one of the doors are not vertical; he therefore orders these to be taken off and refixed.

SUPERINTENDENCE OF PAINTING

MATERIALS FOR PAINTING

95. Preparation for Painting.—Before the painting is commenced, the clerk of works should go over the building and satisfy himself that all the doors swing properly, that they fit the jambs accurately, and that all sashes and drawers work freely. It is occasionally specified that all ironmongery fittings are to be fitted, then removed, and, after the painter has finished all but the last coat, again put in place. This is to prevent the risk of the fittings being smeared or discoloured by the paint. The clerk of works should see that the woodwork is in proper condition before any painting is done. The surfaces should be smooth, free from frost, moisture, dust, or dirt, and all knots should be thoroughly covered with proper knotting. After the priming coat is on and before the second coat is applied, all nail holes, small cracks, etc., must be thoroughly filled with stopping. The clerk of works should see that the stopping is properly forced into the cracks, and not merely smeared over the surface of the work. Any ironwork that is to be painted must be thoroughly cleaned of rust, scale, etc., before any paint is applied.

96. Materials Used.—The various materials that go to make up the paints, varnishes, stains, etc., used in this building are to be the best of their various kinds, and every precaution should be taken to ensure that only the best is used. In important works, if there is any doubt as to the purity of the white lead or linseed oil to be used, they should be submitted to some reputable chemist for analysis. The colour and odour may ordinarily be a good test for linseed oil. The clerk of works may compare the contents of a sample vial of pure oil that he carries in his pocket with some of the oil at the building by pouring the latter into a similar vial carried for the purpose. The usual adulterants are petroleum, resin, and fish oils.

No reducers, except turpentine and linseed oil, should be allowed. Turpentine is sometimes adulterated with kerosene

or other petroleum oils, but it will then leave a greasy stain on white paper, and a drop on a watch glass will reflect prismatic colours in the direct rays of the sun. Putty that contains any other oil than linseed oil should not be allowed on the work, as this is a common cause for spots over nail heads.

97. The clerk of works should be very careful to see that varnishes, stains, and enamels are used without reducing if so required by directions on labels, or, if allowed, then only in proper proportion. All varnish should be brought to the building in sealed cans. If the clerk of works finds the varnish delivered in this condition, he then simply assures himself that the printed directions on the packages are carried out. Probably he can best attain his purpose by examining the materials from time to time and assuring himself that the painter has no oil other than linseed oil, and that this is pure.

EXECUTION OF PAINTING

98. Priming.—When all the woodwork is found in proper condition, it may be primed. For the greater part of the work the priming is done from time to time when the woodwork is ready, some of it before the work leaves the shop. Window frames, sashes, balusters, etc., should be primed in this way. In order that the priming coat may soak in well and serve as a good filler, it should not be too thick. A clerk of works should not hesitate to condemn any primed work sent from the shop that was not properly surfaced before being painted.

99. Workmanship.—The painter should follow the grain of the wood in making the brush strokes, and should work carefully into quirks and corners. Brush marks accurately parallel with the grain and the length of the piece of wood add greatly to the appearance of the work when finished. The smoothness of the paint surface is greatly dependent on the cleanness of the surface before the paint is applied, and the clerk of works should see that the painters carry out the requirements of the specification as to rubbing down the surface with fine glasspaper before each coat is applied.

The blistering of paint is caused in a number of ways ; probably the most common cause is pitch in the wood, although painting on a frosty or damp surface will have a similar effect. In stormy, foggy, or frosty weather, the clerk of works should watch this matter carefully. Too much oil will also have a tendency to cause blisters ; too little oil will cause the paint to powder when dry. Varnish mixed with the paint will give a glossy surface, as will also boiled linseed oil. Each coat should be permitted to dry thoroughly before the following coat is put on.

100. Completion of Building. — The distempering of the kitchen, scullery, and pantry, and of the ceilings, cornices, and friezes of other rooms is carried out at the same time as the general painting. Then, the walls being as dry as can be expected in a new building, the paperhanging is commenced. This, when finished, completes the construction of the building. Before the contractor leaves the premises, the clerk of works should see that the floors are all scrubbed, the stoves blacked, the locks oiled, and the building generally made fit for occupation.

It will be noted that in many cases during the course of the erection of the building the clerk of works has had occasion to take action to see that the drawings and specification were adhered to. With a good contractor his duties would have been less onerous, but with a very bad contractor, he might have found it quite impossible to have obtained the general good standard of workmanship which has been manifested throughout the building.

A SERIES

OF

QUESTIONS AND EXAMPLES

RELATING TO THE SUBJECTS

TREATED OF IN THIS VOLUME.

The following Examination Questions are divided into sections corresponding to the text, so that each section has a head-line which is the same as that of the section to which the questions refer.

No attempt should be made to answer the questions or to solve the examples until the corresponding part of the text has been carefully studied.

SPECIFICATIONS

EXAMINATION QUESTIONS

(1) What is the purpose of a specification ?

(2) How should the clauses in a specification dealing with the laying of drains be written ?

(3) Write a specification of a door that would be suitable for one of the principal rooms of a private house.

(4) Describe, briefly, the purpose of a schedule of dilapidations.

(5) Give the specification clause as to the lead flashings necessary where a sloping roof surface abuts against a vertical face.

(6) (*a*) In what way should the order in which matters are to be dealt with in a specification be decided ? (*b*) Give in their correct order a list of the trades to be dealt with in the specification of a house.

(7) How should the materials to be used in plastering be described ?

(8) (*a*) Write the specification clauses for three kinds of bricks ; (*b*) for fir timber and oak.

(9) What are the principal points to be dealt with in the preliminary clauses of a specification ?

(10) If a tenant is served with a schedule of dilapidations which he deems excessively heavy, what should he do ?

SPECIFICATION MEMORANDA

EXAMINATION QUESTIONS

(1) What methods are used for testing sand to determine the amount of loam it contains ?

(2) How thick should plastering on wooden laths be ?

(3) Can terra-cotta be chiselled ?

(4) What are some of the defects most commonly found in timber ?

(5) What is wired glass ?

(6) What kind of paint is used for metal work ?

(7) What terms are applied to the different hands of doors ?

(8) Describe the best method to adopt in laying concrete.

(9) In good work, how many coats of paint should be applied to new material ?

(10) What is the best way of dealing with the specification for electrical work ?

(11) What is a good paint for a brick wall ?

(12) What is a good method to deafen a floor ?

(13) How should a heating boiler be set and finished ?

(14) What is a direct-indirect radiator ?

(15) What is a plenum system of ventilation ?

(16) Where should striking plates and kicking plates be fixed ?

(17) (*a*) What is scagliola ? (*b*) In what positions should it be used ?

(18) (*a*) What is efflorescence? (*b*) How can it be overcome?

(19) Briefly describe the method of testing a system of gas piping.

(20) (*a*) What is prismatic glass? (*b*) In what positions is it suitable?

QUANTITIES AND ESTIMATING

(PART 1)

EXAMINATION QUESTIONS

(1) Describe the methods given for finding the amount of material, labour, and cost for any given work.

(2) Describe the process of preparing a bill of quantities.

(3) If $\frac{1}{2}\left/\begin{matrix}3\\2\end{matrix}\right/4\left/\begin{matrix}2\\1\end{matrix}\right/$ appears in the timesing, and $\frac{2\cdot0}{2\cdot0}$ in the dimension, columns, what must be entered in the third column?

(4) A piece of stone is 15 inches high, 3 feet 6 inches long, and 9 inches in the wall; how should it be entered on the dimension paper?

(5) Fig. I shows the footings to a $2\frac{1}{2}$-brick wall; how many bricks in thickness will the footings average?

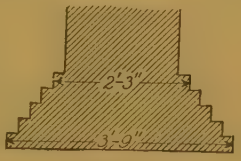

FIG. I

(6) Is any deduction made from brickwork for flues or fireplaces?

(7) When should 1-brick walls be kept separate?

(8) (*a*) At what heights above ground should brickwork be kept separate? (*b*) At what level should stone be kept separate?

(9) In taking off external facing, what allowance should be made below ground level?

(10) What are the main divisions for terra-cotta?

(11) Describe the method of taking off the moulding to the cap and base of a circular stone column.

(12) What is the scantling length for Portland stone?

(13) How is the labour on plain-face stonework described?

(14) In measuring the labours on granite, what is the main difference over those on other stone?

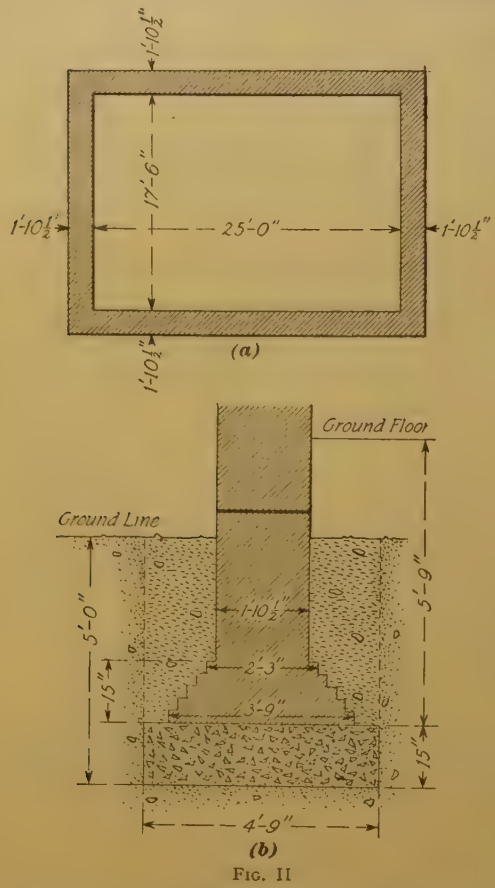

Fig. II

(15) (*a*) Explain the method of finding the number of fir floor joists. (*b*) How many joists are required for a room 18 feet 9 inches long if the joists are $2\frac{1}{2}$ inches thick and 12 inches apart?

Ans. (*b*) 17 joists

(16) (*a*) What is the main difference between carpenters' and joiners' work? (*b*) When should timber be measured per foot cube?

(17) What allowance should be made in the length of a fir trimmer over the net opening to be trimmed?

(18) (*a*) How should counter flooring be measured? (*b*) How should parquet flooring be measured?

(19) What is the allowance for each rivet in riveted steelwork?

(20) Take off the excavation to trenches, separating the carting away from the returning, concrete, footings, damp-proof course, brickwork in mortar, up to 3 feet above ground-floor level, and the external facing up to 9 feet 9 inches above the ground line, to the building shown in Fig. II (*a*). View (*b*) is a section through the walls. Also square the dimensions.

QUANTITIES AND ESTIMATING

(PART 2)

EXAMINATION QUESTIONS

(1) What must the superficial area exceed before deductions from boarding, felt, battens, and slating or tiling are made for chimney stacks passing through roofs ?

(2) What is a fair allowance for the weight of a set of head, nut, and two washers to a 1-inch bolt ? Ans. $3\frac{3}{4}$ lb.

(3) (*a*) What allowance must be made for cutting and waste on roof boarding, felt, and battens for openings in roof for chimney stacks ? (*b*) What allowance must be made for cutting and waste on roof boarding, felt, and battens for a valley ?

(4) (*a*) When are bridging pieces taken ? (*b*) How far apart should they be placed ?

(5) In the measurement of leadwork, what allowance should be made over the measurement on the flat for : (*a*) a $1\frac{1}{2}$-inch drip ? (*b*) a 2-inch roll ? (*c*) a turn-up against brick ? (*d*) What allowance should be made for lead flashings at angles ?

(6) Explain with a sketch the method of finding the length of a hip or valley.

(7) (*a*) Explain the method of obtaining the length of a lead soaker. (*b*) How many soakers would be required to a slope 16 feet 3 inches long if the slates were countess laid to a 4-inch lap ? Ans. (*b*) 25

(8) Fig. 1 (*a*) shows the elevation and (*b*) the plan of an opening in a 14-inch wall faced on both sides with picked stocks ;

the floor on either side of the opening is granolithic $1\frac{1}{2}$ inches thick. Take off all the work and square the dimensions.

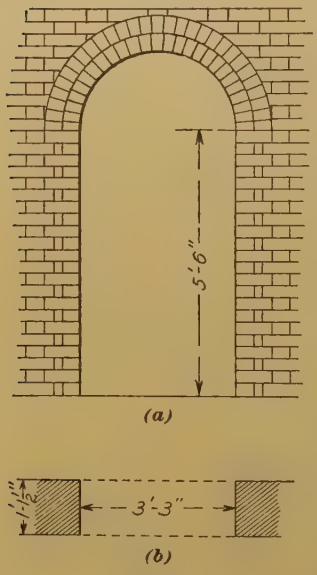

FIG. I

(9) Take off all the work in connection with an internal doorway of which Fig. II is the plan. The opening is to have a fir lintel and rough relieving arch. The skirting on both sides is $1'' \times 9''$ deal, moulded, and the floor is 1-inch deal. The door is to be 2 feet 10 inches by 6 feet 10 inches of 2-inch deal, four-panel, square, and hung on a pair of 4-inch wrought-iron butts to $1\frac{1}{2}$-inch linings fitted with a mortise lock and brass furniture at a prime cost of 10s. complete. It is to be finished on one side with $4'' \times 1\frac{1}{2}''$ deal moulded architrave but no plinth blocks, and on the other side with $2\frac{1}{2}'' \times 1\frac{1}{2}''$ chamfered fillet. All the woodwork is to be painted four coats. Square the dimensions.

(10) When would joiner's work be described as cross-tongued: (*a*) in deal? (*b*) in hardwoods?

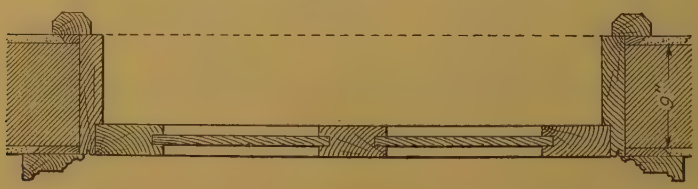

FIG. II

(11) Take off the amount of Portland-cement flush-beaded skirting 9 inches high to a room of which Fig. III is the plan. The skirting is to be painted four coats.

(12) Take off all work in connection with the window shown in Fig. IV, (*a*) being the external elevation, (*b*) the section, and

(*c*) the plan. The wall is faced outside with picked stock bricks. The opening is to have a York-stone sill, gauged red-brick arch, and concrete lintel 9 inches high. The cased frame is to have a teak sill. The sashes are to be glazed with 21-ounce sheet glass and the woodwork painted four coats. Include for sash fastener at the prime cost of 1s. 6d.; sash lifts at the prime cost of 1s. each; pull-down handles at the prime cost of 1s. 6d. each; and set of handles, pulleys, etc., to open and close top sashes in cased frames at the prime cost of 7s. 6d. the set. The linings are to be 1 inch thick. Square the dimensions.

(13) Take off the plastering to a room having the plan shown in Fig. III. The ceiling is to be lathed, plastered, floated, and set and to have a moulded cornice 12 inches girth. The walls are to be rendered, floated, and set above the cement skirting 9 inches high that was previously taken. Twice whiten ceilings and cornices and twice distemper a tint on walls. Assume the height of room from floor to ceiling to be 11 feet. Square the dimensions.

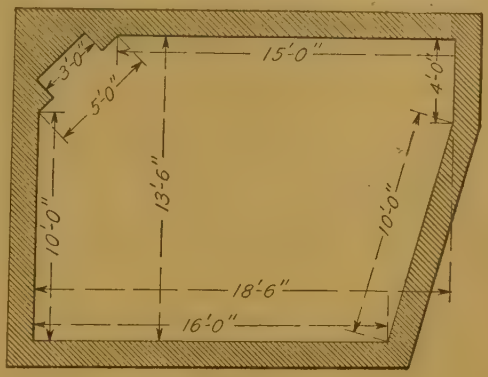

FIG. III

(14) (*a*) Explain the method of finding the measurement of winders and risers in a wooden staircase. (*b*) Take off the treads and risers and the winders and risers to the staircase shown in Fig. V. The floor *b* is 6 feet 3 inches above the floor *a*; the width shown is in the clear of the close strings; the treads are $1\frac{1}{4}$ inches thick and have moulded nosings. The length of riser to winder 4 is 3 feet and to 5 and 6 each 3 feet 5 inches. Square the dimensions.

(15) A water-closet that consists of pan and trap in one piece of earthenware must be connected to a 4-inch branch lead soil pipe; give the description of the item that will be taken for the joint.

(16) (*a*) Explain the method of arriving at the depth of manholes in a drainage system. (*b*) What is the depth of a manhole 120 feet from the commencement of a drainage system if there is a gully at the starting point, the drain from which is 18 inches deep, and the fall of drain is 1 in 40?

Ans. (*b*) 4 ft. 6 in.

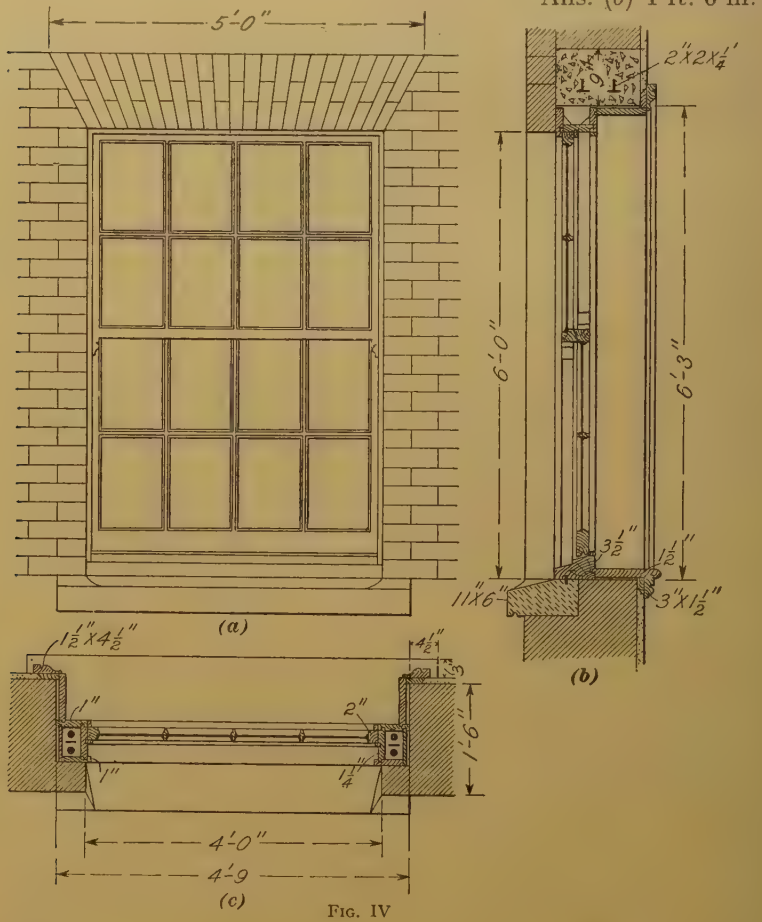

FIG. IV

(17) When would bends in lead pipes be measured?

(18) In stating the size of ironmongery, explain how the measurements would be made: (*a*) for butts; (*b*) for bolts; (*c*) for lock furniture.

(19) Explain the method of finding the measurement of glass in sashes of cased frames when no details are given.

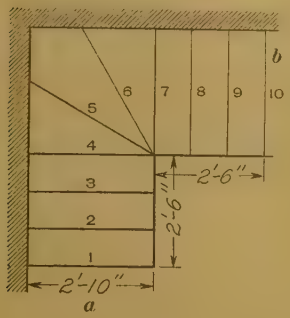

Fig. V

Fig. VI

(20) (*a*) How should the painting on windows be measured? (*b*) Give the items that would be required for painting the inside and outside of the window shown in Fig. VI.

QUANTITIES AND ESTIMATING

(PART 3)

EXAMINATION QUESTIONS

(1) Explain the method of referencing items on the abstract and give one or two examples.

(2) State how a sheet of abstract fairly full of items would be read so as to find the correct order of the items.

(3) What is meant by writing short, in abstracting ?

(4) Give the order for abstracting the cubic items of fir.

(5) Give the order for abstracting stonework for dressings, etc., when the cube stone includes all labours.

(6) What is the general order for the joiner's abstract ?

(7) Give the order for abstracting the following items of breeze concrete : Breeze-concrete lintel 9-inch soffit and 6 inches high, including two $2'' \times 2'' \times \frac{1}{4}''$ **T** cores ; breeze-concrete flat 7 inches thick over fifth floor ; breeze-concrete floor 7 inches thick at second-floor level ; breeze-concrete lintel $4\frac{1}{2}$-inch soffit and 6 inches high, including one $2'' \times 2'' \times \frac{1}{4}''$ **T** core ; breeze-concrete flat 9 inches thick over first floor ; breeze-concrete floor 6 inches thick at ground-floor level ; breeze-concrete lintel $13\frac{1}{2}$-inch soffit and 9 inches high, core measured separately ; breeze-concrete flat 9 inches thick over fourth floor ; breeze-concrete floor 9 inches thick at first-floor level.

(8) What would be the order of steelwork on the founder and smith's abstract ?

(9) The following items occur on dimensions ; in what trade would they be abstracted and in what order : Iron tongue, rim

locks, sash lifts, casement stays, barrel bolts, butts, swing hinges, sash fasteners, iron dowels and mortise locks ?

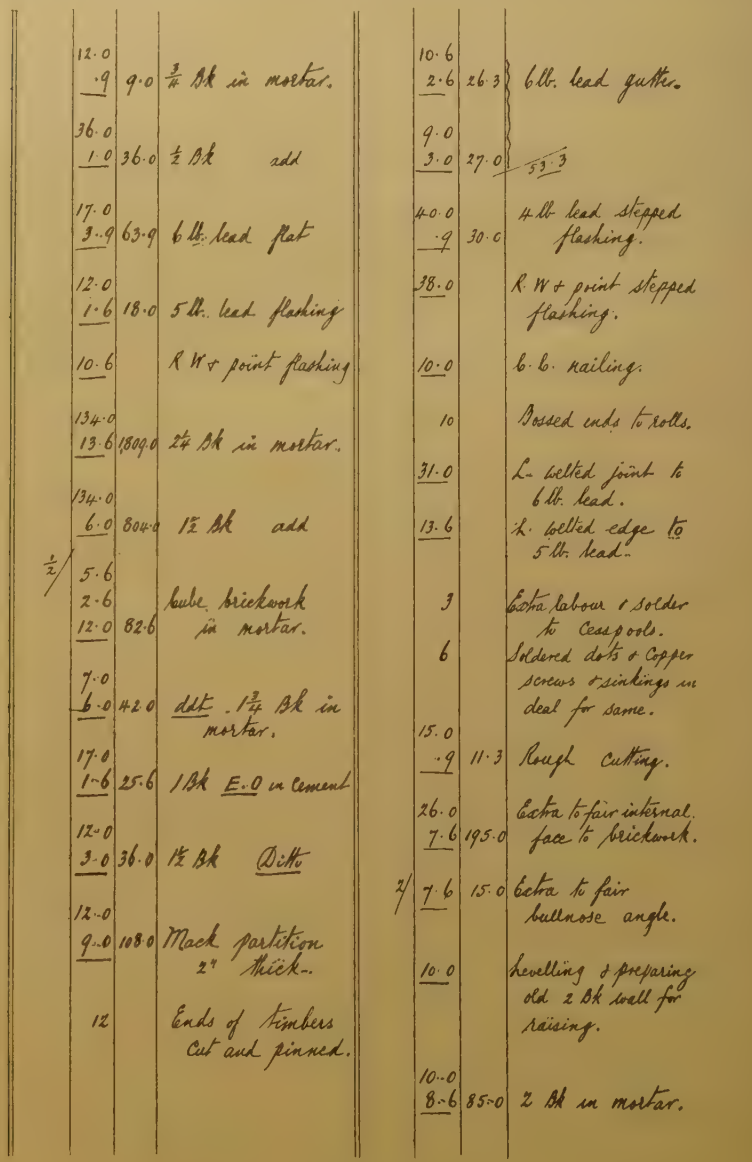
12·0
·9 9·0 ¾ Bk in mortar.
36·0
1·0 36·0 ½ Bk add
17·0
3·9 63·9 6 lb. lead flat
12·0
1·6 18·0 5 lb. lead flashing
10·6 R W & point flashing
134·0
13·6 1809·0 2¼ Bk in mortar.
134·0
6·0 804·0 1½ Bk add
½ 5·6
2·6 tube brickwork
12·0 82·6 in mortar.
7·0
6·0 42·0 ddt. 1¾ Bk in mortar.
17·0
1·6 25·6 1 Bk E.O in Cement
12·0
3·0 36·0 1½ Bk Ditto
12·0
9·0 108·0 Mark partition 2" thick.
12 Ends of timbers Cut and pinned.
10·6
2·6 26·3 6 lb. lead gutter.
9·0
3·0 27·0 53·3
40·0
·9 30·0 4 lb lead stepped flashing.
38·0 R W & point stepped flashing.
10·0 6·6. nailing.
10 Bossed ends to rolls.
31·0 L. welted joint to 6 lb. lead.
13·6 L. welted edge to 5 lb. lead.
3 Extra labour & Solder to Cesspools.
6 Soldered dots & Copper screws & sinkings in deal for same.
15·0
·9 11·3 Rough Cutting.
26·0
7·6 195·0 Extra to fair internal face to brickwork.
7/ 7·6 15·0 Extra to fair bullnose angle.
10·0 levelling & preparing old 2 Bk wall for raising.
10·0
8·6 85·0 2 Bk in mortar.

FIG. I

(10) Give the correct order for abstracting the following items on the plasterer's abstracts: Plaster-moulded cornice 9-inch girth; lath, plaster, float, and set ceilings; render, float, and set walls; Keene's cement skirtings, rough render behind skirtings; floated bed for asphalt; mitres to moulded cornice, 9-inch girth; and lath, plaster, float, and set partitions.

(11) Rule or fold up a plain sheet of foolscap paper and abstract the items given in Fig. I; the front of the abstract can be used for the bricklayer and the back for the plumber. Also cast and reduce the abstract ready for billing.

(12) Give the order of trades for billing.

(13) What clause should be written at the end of the tiler's bill?

(14) From the abstract made from Fig. I, on a sheet of ruled or folded foolscap paper, write the bill for the plumber's work. The preamble is to be "all lead to be milled and to hold the full weights specified."

(15) When casting and reducing on the founder and smith's abstract, at what weight should a foot superficial of steel $\frac{1}{2}$ inch thick be taken?

(16) Rule or fold up a sheet of plain foolscap paper and write the bill of the items given in Fig. 9. Assume that the preamble to the carpenter's bill is written, so commence at the top of the page with £ s. d.

(17) When is a credit, or spot, bill required?

(18) What are variations or accounts?

(19) What is an alternative estimate?

(20) (*a*) When are schedules used? (*b*) What is the main difference between a schedule and a bill of quantities?

QUANTITIES AND ESTIMATING

(PART 4)

EXAMINATION QUESTIONS

(1) What is the best and most accurate method of approximate estimating?

(2) When is approximate estimating per unit of accommodation used?

(3) Describe the method of measurement for approximate estimating per foot cube.

(4) Give three methods of preparing approximate estimates.

(5) Find, by cubing, the approximate cost of a building having a frontage of 125 feet 3 inches and a depth of 52 feet 5 inches all in clear between walls. The front and back walls are $22\frac{1}{2}$ inches thick and the side walls 18 inches thick. The height from bottom of footings to eaves is 23 feet 6 inches and the height from eaves to ridge is 12 feet; there are attics in the roof. The value per foot cube can be taken at 11d. £150 is to be included for contingencies and £250 for boundary walls and gates. Ans. £11,130 0s. 10d.

(6) When estimating by rough quantities and approximate prices, what will be the price: (*a*) of stud partitions per square; (*b*) per foot superficial of a lead flat covered with 6-pound lead?

(7) How does the method of measurement for approximate estimating by rough quantities vary from the method of measurement for bills of quantities?

(8) What are establishment charges?

(9) What must the cost of labour include?

(10) Give a few of the conditions that influence the price of work and must be taken into consideration when pricing.

(11) What are the three main factors which form the basis of all prices?

(12) In pricing the item of maintenance in a bill of quantities, what is the value per £1,000 of work?

(13) What are the main factors in pricing concrete?

(14) (*a*) How many bricks are required for a standard rod of brickwork? (*b*) How much mortar is required for a rod of brickwork?

(15) How many cubic yards of digging in chalk and throwing out can be done by one man in 1 hour?

(16) How does the cost of labour on Bath stone compare with that on Portland stone?

(17) What number of facing bricks are required to the foot superficial of facing?

(18) How much rough stone will be required for 1 yard cube of coursed rubble walling?

(19) Give the amount of materials required and the time taken for executing 1 yard superficial of lath, plaster, float, and set.

(20) How many plain tiles are required to a square of 100 feet superficial of roofing, if the tiles are laid to a 3-inch gauge?

LONDON BUILDING LAW
(PART 1)

EXAMINATION QUESTIONS

(1) By what authorities is the London building law administered ?

(2) What is the chief Act affecting building work in London, and what are the principal matters with which it deals ?

(3) What is a building of the warehouse class ?

(4) What is meant by prescribed distance ?

(5) If it is desired to know the position of the general line of buildings in any street, what course must be adopted ?

(6) To what extent may a shop front project in front of the face of the building to which it belongs if the width of the street is 40 feet ?

(7) (*a*) What is the minimum area of the open space required to be provided at the rear of a domestic building ? (*b*) What is the minimum depth ?

(8) What must be done before it is possible to form a new street in London ?

(9) What is a party wall ?

(10) The front wall of a building of the warehouse class is 42 feet long, and the vertical distance from the base of the wall to the top of the topmost story of the building is 66 feet ; what must be the thickness of the wall (*a*) at the top ? (*b*) at the base ?

(11) Is there any limit to the amount of recesses which may be formed in an external wall ?

(12) With regard to party structures, what are the rights of (*a*) a building owner ? (*b*) an adjoining owner ?

(13) What rules apply to the carrying up of party walls above the roof ?

(14) To what maximum height is it possible to erect a building in London without special consent ?

(15) How is the thickness of walls of public buildings regulated ?

(16) If a domestic building abuts on a street formed in 1890, at what level must the horizontal line be drawn ?

(17) What procedure must be adopted if it is desired to erect a temporary building ?

(18) What rules apply as to the height of, and the window space to be provided in the construction of, habitable rooms ?

(19) What open space must be provided in the case of a habitable basement ?

(20) When may work be commenced if a notice is served in relation to (*a*) a party fence wall ? (*b*) any other party structure ?

LONDON BUILDING LAW

(PART 2)

EXAMINATION QUESTIONS

(1) With what local body must plans for drainage work be deposited ?

(2) What are the principal sections in the London Building Acts (Amendment) Act, 1905, and with what subjects do they respectively deal ?

(3) Give a summary of the materials that are considered fire-resisting under the London Building Acts.

(4) What is the largest opening that can be made without the consent of the Council in a party wall separating buildings in the same occupation ?

(5) What is the ordinary limit of cubical extent, and to what buildings does this apply ?

(6) State the superimposed loads on floors and roofs allowed by the London County Council (General Powers) Act, 1909.

(7) Quote the working stresses on iron and steel as given in the London County Council (General Powers) Act, 1909.

(8) What is the minimum size, in London, for (*a*) a ventilating pipe and (*b*) a soil pipe ?

(9) State the requirements of Section 14 of the Factory and Workshop Act, 1901, with respect to (*a*) factories and workshops of comparatively recent erection and (*b*) old factories and workshops.

(10) State the complete requirements of the Metropolitan by-laws with regard to the position of water-closets.

(11) State, in outline, the requirements of the London County Council (General Powers) Act, 1902, with regard to common lodging houses.

(12) What are the rules given in the London County Council (General Powers) Act, 1909, with regard to the use of rivets ?

(13) State the constructional requirements of the Metropolitan by-laws with regard to new streets.

(14) What is an underground room within the meaning of the Public Health (London) Act, 1891 ?

(15) If a borough council propose to make up a private street and to charge the owners with the cost, have these latter any remedy if they object to the street being thus dealt with ?

(16) State the respective scope of four important sets of regulations that have been made by the London County Council.

(17) Of what material must a soil pipe be constructed if it occurs inside a building ?

(18) What are the requirements of the London County Council by-laws with regard to plastering ?

(19) State one important class of buildings that are exempt from the London Building Acts (Amendment) Act, 1905 ?

(20) What portion of the London building law deals with the roofs of projecting shops, and what are the requirements with regard to these ?

PROVINCIAL BUILDING LAW

EXAMINATION QUESTIONS

(1) What are the principal Acts of Parliament affecting the erection of buildings in provincial towns in England and Wales?

(2) (*a*) By whom are the building regulations administered in Scotland and in Ireland? (*b*) State the principal Act of Parliament affecting building work in each of these two countries.

(3) Why do the building regulations differ in districts in the same country?

(4) What are the definitions of drain and sewer that are given in the Public Health Act, 1875?

(5) (*a*) What is an arbitration? (*b*) How is it conducted?

(6) What are the requirements governing the frontage lines of new buildings in England and Wales?

(7) Under what two Acts of Parliament may private street works be carried out by local authorities?

(8) Have local authorities power to require the taking down of a dangerous building? State the reasons for answer.

(9) What are the model by-laws?

(10) State the rules for recesses in external and party walls which are given in the urban model by-laws.

(11) How are private street expenses required to be apportioned under the Public Health Act, 1875?

(12) What are the requirements of the rural model by-laws as to the provision of concrete over the site of a building?

(13) What are the rules in the urban model by-laws for the carrying up of party walls above roofs?

(14) Are the requirements of Part III of the Public Health Acts Amendment Act, 1890, of general application or do they apply in certain districts only?

(15) What are the rules as to the ventilation of habitable rooms as stated in: (*a*) the urban model by-laws? (*b*) the rural model by-laws?

(16) State the rules of the urban by-laws with regard to the situation, lighting, and ventilation of a water-closet when placed inside a building.

(17) What are the requirements as to air space at the rear of buildings abutting on a single street as given in the urban model by-laws?

(18) Are privies allowed by the model by-laws to be placed inside buildings?

(19) State the rules of the urban model by-laws which affect the construction of roofs.

(20) When, under the urban model by-laws, may the space ordinarily required to be provided at the rear of a building be provided at the side of the building?

EASEMENTS

EXAMINATION QUESTIONS

(1) What is an easement, and how does it differ from a profit à prendre ?

(2) In what several ways may easements be acquired ?

(3) Explain the terms dominant tenement, servient tenement, quasi-easement, and easement of necessity.

(4) State three natural rights appertaining to property.

(5) When a tenement in separate ownership is sold, what happens to any easements held in respect of it ?

(6) Is there any kind of easement that may be acquired by a tenant ?

(7) What are the main provisions of Sections 2 and 3 of the Prescription Act, 1832, and in what portions of the United Kingdom does the Act apply ?

(8) Is it in any case permissible to increase the burden imposed on a tenement by an easement ?

(9) What was the main point determined by the House of Lords in *Colls* v. *Home and Colonial Stores, Ltd.* ?

(10) What steps should be taken to avoid abandonment of rights of light in the case of a building which is taken down and not immediately re-erected ?

(11) What are party walls termed in Scotland, and what are the rights of owners in respect of them ?

(12) Give a brief summary of the case of *Dalton* v. *Angus*.

(13) What, from the practical standpoint, is the length of enjoyment required to enable a claim for an easement of light to be substantiated ?

(14) Can an owner who erects a party wall recoup himself in some measure for the expense of erection, if the wall is afterwards used by the owner of the property on the other side of the wall ?

(15) A person enjoys an exceptional amount of light and requires the same for the purpose of his business ; can he establish a claim by prescription to such exceptional amount of light ?

(16) What is an interruption of an easement within the meaning of the Prescription Act, 1832 ?

(17) Two tenements, mutually interdependent and belonging to the same owner, are both sold ; how do the dates of the respective sales affect the question of whether or not the ordinary quasi-easements have their existence continued as easements ?

(18) What are the proper steps to be taken by an owner if he desires to prevent (*a*) the acquisition of an easement over his tenement and (*b*) the loss of an easement held by him in respect of his tenement ?

(19) Give an example of (*a*) a positive easement and (*b*) a negative easement.

(20) Does the possession of an easement of way imply a right of way for all purposes ?

BUILDING CONTRACTS

EXAMINATION QUESTIONS

(1) What are the three essentials of a simple contract ?

(2) What is a sufficient consideration for a contract ?

(3) Is there any objection to the quantities being made part of a building contract : (*a*) from the architect's point of view ? (*b*) from the contractor's point of view ?

(4) Under what special circumstances will it be desirable to adopt a schedule of prices instead of a bill of quantities ?

(5) What precaution must an architect take in entering into a contract with a corporate body ?

(6) What is the position of the contractor with regard to obtaining payment for work done when the agreement provides for payment being made on the architect's certificate ?

(7) What is the responsibility of the architect under a contract : (*a*) to his employer ? (*b*) to the contractor ?

(8) What must the architect do to avoid being held personally responsible for orders he may give on behalf of his employer ?

(9) What matters are stated by the schedule of conditions of contract issued by the Royal Institute of British Architects to be made subjects of reference to the arbitrator ?

(10) To what extent does the death of one of the parties affect the contract, in the case of : (*a*) a contract between architect and client ? (*b*) a contract between building owner and builder ?

BUILDING SUPERINTENDENCE

(PART 1)

EXAMINATION QUESTIONS

(1) Define land surveying.

(2) Describe, as far as Sta. 4, the various steps taken in running a section level of which the following are the notes :

Back-sight	Inter-mediate	Fore-sight	Rise	Fall	Height Above Datum	Mark	Distance Total	Remarks
4·57					91·39	B.M.		Starting point
		3·72				Sta. 1	100	Changing Sta.
5·42								
	4·50					Sta. 2	200	
		3·17				Sta. 3	300	Changing Sta.
4·91								
	4·90						340	
		6·38				Sta. 4	400	Changing Sta.
3·38								
	4·60					Sta. 5	500	
		5·40				Sta. 6	600	Changing Sta.
2·76								
	3·10						670	
	3·80					Sta. 7	700	
		6·92				Sta. 8	800	Closing Sta.

(3) What is meant by the system of triangulation ?

(4) Describe : (*a*) a surveyor's chain ; (*b*) poles and arrows.

(5) Explain the method of ranging of poles in a survey.

(6) Work out the rises and falls from the notes given in question 2, also the heights above datum. Give proof of the correctness of the figures.

(7) (*a*) What are offsets ? (*b*) Why are they taken ?

(8) Describe the surveyor's level.

(9) Define the terms: (*a*) backsight ; (*b*) foresight ; (*c*) intermediate sights ; (*d*) changing station.

(10) (*a*) What is a bench mark ? (*b*) How is it abbreviated in surveying ? (*c*) What is the meaning of O.B.M. ?

(11) Draw a section from the notes given in question 2, using a scale of 10 feet to the inch for vertical distances, and a scale of 100 feet to the inch for horizontal distances.

(12) (*a*) What is a measured drawing of an existing building ? (*b*) How would the thickness of a wall in which there is no opening be determined ?

(13) In a chain survey : (*a*) Who is the leader, and what are his duties ? (*b*) Who is the follower, and what are his duties ?

(14) In measuring, why is it necessary to have a uniform pull on the chain or tape ?

(15) In reading a levelling staff, what points should be borne in mind in order to prevent inaccuracy and mistakes ?

(16) Explain, in detail, the chaining of a line from one station to another, and the method of determining its exact length.

(17) Explain fully, giving diagram, how it is possible to determine the distance to an inaccessible point.

(18) State the different adjustments of the dumpy level and explain each fully.

(19) What is a datum line ?

(20) Explain, with a diagram, how it is possible to run a chain line over a hill when the ends of a line are invisible from each other.

BUILDING SUPERINTENDENCE

(PART 2)

EXAMINATION QUESTIONS

(1) In what relation does the clerk of works stand to the architect?

(2) (*a*) What is an architect's certificate? (*b*) To whom should it be sent?

(3) When should the clerk of works inspect the materials which arrive on the site?

(4) Show, by a sketch, the method of setting out a right angle by means of the 3-4-5 rule.

(5) What should be done with material excavated from a building site?

(6) How are flues liable to be partially blocked during the course of their construction, and how should this defect be avoided?

(7) What action should be taken by the clerk of works or architect if it is found that the sand used in the formation of mortar contains loam?

(8) What points are to be observed in the inspection of timber?

(9) Illustrate, by a sketch, the method of setting out a building.

(10) What rough test may be adopted in order to ascertain whether a sample of freshly mixed mortar contains the proper proportion of lime?

(11) (*a*) State the two methods which may be adopted in forming a vertical damp-proof course of asphalt. (*b*) What precaution should be taken in the inspection of this work?

(12) Why should the sills of windows and other similar projecting features of stone be covered with boards during the course of the erection of the building?

(13) State two important points that should be watched in superintending the construction of a timber floor.

(14) Give a concise description of the proper method of mixing concrete.

(15) What is the object of a requirement to the effect that the brickwork of walls is to be grouted up at every fourth course?

(16) Where hips occur in a roof, what form of construction should be adopted at the points where the hip timbers take their bearing on the walls?

(17) (*a*) What are the chief records that should be kept by a clerk of works? (*b*) How does he keep the architect informed of the progress of the work?

(18) (*a*) What is boulder concrete? (*b*) When may it advantageously be used?

(19) State the defects likely to be found in lime.

(20) Explain the method of setting out a right angle by means of a builder's square.

BUILDING SUPERINTENDENCE

(PART 3)

EXAMINATION QUESTIONS

(1) What determines the spacing of slate and tile battens ?

(2) What are the points to be observed when examining wood for joinery ?

(3) Why should the outlets of gutters be arranged immediately over the gullies below, whenever possible ?

(4) For what purpose are grounds provided and at what stage of the building operations are they fixed ?

(5) Why do some architects require eaves gutters and rainwater pipes to be given one coat of paint at the manufacturer's ?

(6) Describe the full operation of making plasterers' coarse stuff.

(7) At what stage in the operation of plastering are the screeds formed ?

(8) State the principal points to be observed when inspecting the fixing of a water-closet apparatus.

(9) How should the flue of a copper be constructed ?

(10) For what reason should the back of wood panelling be given a coat of priming ?

(11) When is it desirable to use $1\frac{1}{2}$ pairs of butts for hanging a door ?

(12) How may the construction of an electric-lighting system be economically supervised ?

(13) State the order in which the erection of a building proceeds, after the construction of the brickwork of the walls,

of the timber framework of the roof, and of the drainage work outside the building has been completed.

(14) Why is it desirable to supervise the provision of the specified fall in the case of lead gutters ?

(15) How should a gauge be used when testing the thickness of a material ?

(16) Why are floor boards of the best character of much less width than ordinary floor boards ?

(17) What are the principal points to be watched when superintending the installation of a cold-water supply ?

(18) How should the joints at the angles of skirtings be constructed ?

(19) How is a staircase set out ?

(20) What are the points to be observed when supervising painting ?

ANSWERS

TO THE

QUESTIONS AND EXAMPLES

INCLUDED IN THE

EXAMINATION QUESTIONS.

Each Key, or set of Answers, has the same section number as the corresponding set of Examination Questions. All references are to the portion of the text that bears the same section number as the Key in which the references occur, unless the title of some other part of the text is mentioned.

To be of the greatest value, the Key should be consulted sparingly, much in the same manner as a pupil would go to a teacher for assistance in solving a problem he is unable to master unaided. The Key should not be referred to except as a last resource, when the student has failed, after using every reasonable effort, to solve the example or answer the question. If used in this way, the Key will be a help and a source of encouragement in studying the various subjects comprising the Course.

SPECIFICATIONS

(1) See Art. **1.**

(2) See Arts. **55** and **57.**

(3) See Arts. **162** and **163.**

(4) See Arts. **265** and **266.**

(5) See Art. **209.**

(6) (*a*) and (*b*) See Arts. **2** and **5.**

(7) See Arts. **231** to **235.**

(8) (*a*) See Arts. **69, 71,** and **72.**
(*b*) See Arts. **128** and **129.**

(9) See Arts. **13** to **39.**

(10) See Art. **266.**

SPECIFICATION MEMORANDA

(1) See Art. **45.**
(2) See Art. **284.**
(3) See Art. **88.**
(4) See Art. **106.**
(5) See Art. **297.**
(6) See Art. **324.**
(7) See Art. **139.**
(8) See Art. **23.**
(9) See Art. **318.**
(10) See Art. **278.**
(11) See Art. **310.**
(12) See Art. **117.**
(13) See Art. **212.**
(14) See Art. **226.**
(15) See Art. **231.**
(16) See Arts. **184** and **185.**
(17) (*a*) and (*b*) See Art. **98.**
(18) (*a*) and (*b*) See Art. **58.**
(19) See Art. **261.**
(20) (*a*) and (*b*) See Art. **298.**

QUANTITIES AND ESTIMATING

(PART 1)

(1) See Art. **3.**

(2) See Art. **4.**

(3) From Arts. **9** to **12,** this is $\frac{1}{2} \times (3 + 2) \times 4 \times (2 + 1) \times (2$ ft. $\times 2$ ft.$) = 120$ ft. super., which would be entered 120·0. Ans.

(4) From Art. **18,** this would be written 3·6
·9
1·3

(5) From Art. **45,** this is found to be 4 bricks. Ans.

(6) According to Art. **44,** deductions are made for fireplaces only, and not for flues.

(7) According to Art. **40,** when they are faced and pointed on both sides.

(8) (*a*) See Art. **40.**
(*b*) See Art. **74.**

(9) See Art. **68.**

(10) See Art. **72.**

(11) See Art. **85.**

(12) See Art. **74.**

(13) See Art. **81.**

(14) See Art. **93.**

(15) (*a*) See Art. **139.**
(*b*) See Art. **139.**
18 ft. 9 in. $\div$ (12 in. $+ 2\frac{1}{2}$ in.) $+ 1 = 17$ joists. Ans.

(16) (*a*) See Art. **137.**
(*b*) See Art. **138.**

(17) See Art. **145.**

(18) (*a*) and (*b*) See Art. **142.**

(19) See Art. **156.**

(20) See Arts. **35, 37, 39, 45, 49, 50, 63,** and Fig. **1.**

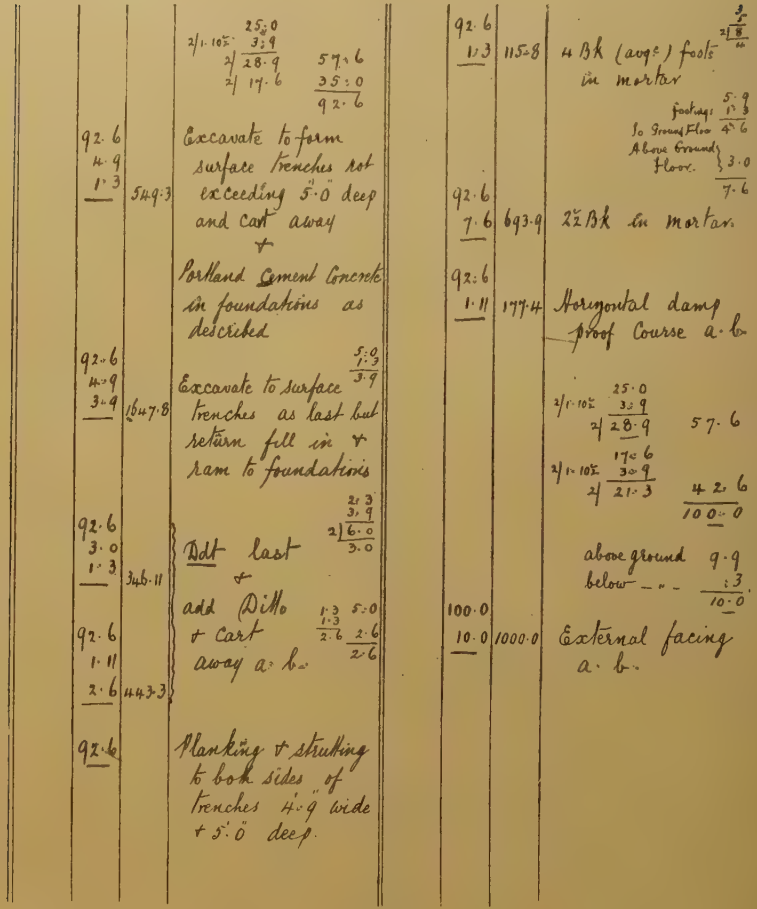
Excavate to form surface trenches not exceeding 5'·0" deep and cart away
Portland Cement Concrete in foundations as described
Excavate to surface trenches as last but return fill in & ram to foundations
Ddt last
add Ditto & Cart away a·b·
Planking & strutting to both sides of trenches 4'·9" wide & 5'·0" deep.
4 Bk (avge) footings in mortar
Footings
To Ground Floor
Above Ground Floor
2½ Bk in mortar.
Horizontal damp proof Course a·b·
above ground
below
External facing a·b·

FIG. 1

QUANTITIES AND ESTIMATING

(PART 2)

(i) See Art. **85.**

(2) See Art. **31.** $1\frac{1}{4} + (1\frac{1}{4} \times 2) = 3\frac{3}{4}$ lb. Ans.

(3) (*a*) The length round the edges of the opening supered by 3 in. Ans. See Art. **85.**

(*b*) The length of the valley supered by 3 in. and multiplied by 2 for both sides. Ans. See Art. **67.**

(4) (*a*) and (*b*) See Art. **2.**

(5) (*a*), (*b*), and (*c*) See Art. **12.**
(*d*) See Art. **14.**

(6) See Art. **47.**

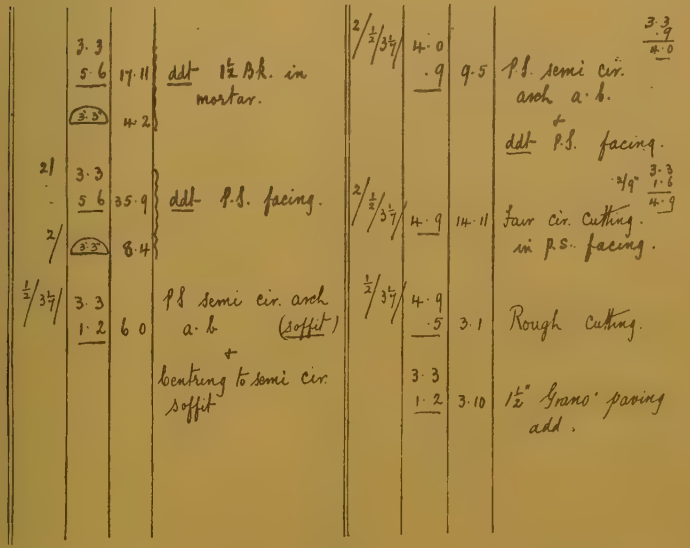

FIG. 1

			2/1" 2·10 ·2 3·0 6·10 1 6·11
	3·0 6·11	20·9	ddt 1 Bk. in mortar.
2/	3·0	6·0	ddt 1"×9" Deal brot & moulded skirting on & including grounds & backings plugged & 4s
	2/2	= 4	Housed or fitted ends.
2/	3·0 6·11	41·6	ddt R. F. & S walls & 2ce distemper a tint.
	3·0 ·9	2·3	1" Flooring & bearers in opening a. b. 2/9" 3·0 1·6 4·6
	4·6 ·9 ·3	·10"	Fir lintel.
	1		Extra to rough relieving arch over lintel 4'·6" span & 9" soffit in two h. b. rings in cement including all cutting
	2/4	= 8	Fixing bricks a. b. 2/3/4" 9" 1½ 10½ 2/6·11 3·0 13·10 16·10
	16·10 ·11	15·5	1½" brot Crosstongued rabbeted & beaded linings tongued

			at angles & including backings.
	2·10 6·10	19·4	2" four panel square door,
	1		Pair 4" to I. butts.
	1		Mortise lock & brass furniture p.c 10s/- complete, 4/3" 16·10 1·0 17·10
	17·10		¾"×3" framed & splayed grounds. 4/4" 16·10 1·4 18·2
	18·2		1½×4" Moulded & mitred architrave. 4/2" 16·10 ·8 17·6
	17·6		1½×2½ brot and twice chamfered fillet mitred as architrave & ¾" Narrow framed & splayed grounds.
	16·10 1·1	18·3	4s ÷ 9 linings
2/	2·10 6·10	38·9	4s ÷ 8 door
	18·2 ·9	13·8	4s ÷ 9 architrave
	17·6 ·6	8·9	architrave

FIG. 2.

(7) (*a*) See Art. **81.**

(*b*) From Art. **81,** the gauge would be length of slate 20 in. minus the lap 4 in. divided by 2, which gives 8 in. The length of slope is 195 in.; this divided by the gauge 8 in. equals over 24, which is called 25. Ans.

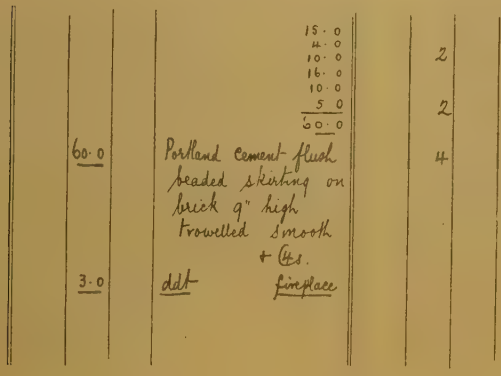

FIG. 3

(8) See Arts. **132** to **138**; also Fig. 1.

(9) See Arts. **186** to **193** and Fig. 2.

(10) (*a*) and (*b*) See Art. **141.**

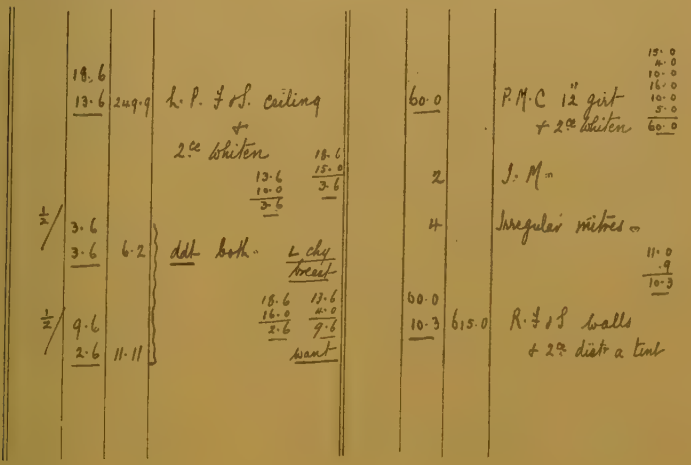

FIG. 4

(11) See Art. **211** and Fig. 3.

(12) See Arts. **218, 219, 222,** and Fig. 4.

(13) See Arts. **156** to **185**; also Fig. 5 (*a*), (*b*), and (*c*).

	4·0 6·0	24·0	ddt ½ Bk in mortar + ddt P.S. facing
2/	·5 6·0	5·0	P.S. facing reveals
	4·0 ·5	1·8	Extra (over ordinary brickwork) to red brick rubbed & gauged straight arch set in putty.
	4·6 1·0	4·6	add arch + ddt P.S. facing.
	4·0		Turning piece to 4½" straight soffit.
2/	1·1	2·2	Fair skewback cutting in p.s. facing.
	4·9		11"×6" Y.S. rubbed, sunk weathered & throated window sill grooved for metal tongue.
	2		Fair stooled ends including stops to throat.
	2		Make good p.s. facing to window sills.

5·0
4·0
2 | 9·0
4·6

1·0
·1
1·1

2/4½ 4·0
·9
4·9

2/3	·6	Breeze Concrete fixing bricks a.b.
1		L. frame b & p.
4·9 6·3	29·8	ddt 1½ Bk in mortar + ddt R.F. & S walls & 2ce distr a tint.
5·6		Breeze Concrete lintel 13½" on soffit & 9" high Composed of 1 part of P.C to 5 parts of Coke breeze with & including two 2"×2"×¼" T's running the whole length of lintel & including mould & hoisting & setting. (Brickwork has not been deducted)
4·9		1"×¼" G.I. tongue & bedding same & sash sill in white lead.
4·9 6·3	29·8	Deal cased frame Consisting of 1" inner & outer linings, 1¼" pulley stiles & head, back linings parting beads & slips, 3½" Teak sunk & twice weathered sill grooved for metal (Contd.)

2/4½ 4·9
·9
5·6

FIG. 5 (a)

			tongue 2" deal moulded sashes each in 8 squares, double hung with best brass axle pulleys, flax lines, and iron weights; the bottom edge of bottom sashes splayed & hollow grooved & the meeting rails of sashes splayed.
	2/2	= 4	Extra to moulded horns to 2" sashes
	1		Brass sash fastener p c 1/6
	2		Brass sash lifts p.c 1/- each + Brass pull down handles p.c 1/6 each
	1		Set of handles, pulleys &c to open & close top sashes in cased frames p.c 7/6 per set.
			6.3 / 1.0 / 4 | 5 3 / 1 3¾ — 4 9 / 1 6 / 4 | 3 9 / .11¼
2/8/	1.0 / 1.4	21.4	21 oz sheet glass & glazing in squares n.e. 2.0" super.
			linings 2/1 2" — 2/4½ 4 9 / 9 / 5 6
			sashes 2/2 4
			Parting ¼ / 6¼

		Reveal 1.1½
		Plaster ¾
		1.2¼
		frame & sashes 6¼
		tongue = .8½
		nosing = 3
		11½"
5 6 / 1.0	5.6	1½" Deal wrot Crosstongued & rounded window board tongued to teak sill including groove & bearers.
2		Notched returned rounded ends to 1½ rounded window board.
5 6		3"×1½" Moulding tongued in to underside of window board including groove.
2		R.M. ends.
		11½ / 3 / 8½ — 2/6.3 — 4 9 / 12 6 / 17.3
17.3 / .9	12.11	1" Deal wrot window linings tongued one edge to frame including groove & tongued at angles including backings
		4/3" 17 3 / 1 0 / 18 3
18.3		¾"×3" Framed & splayed grounds
		4/4" 17 3 / 1 4 / 18 7
18.7		1½×4½ Moulded & mitred architrave.

FIG. 5 (b)

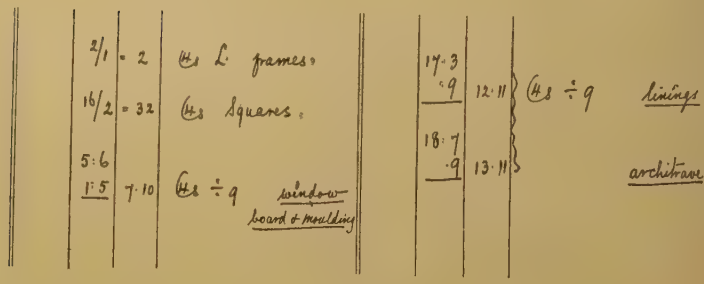

FIG. 5 (*c*)

(14) (*a*) See Art. **195.**

(*b*) See Arts. **194, 195,** and Fig. **6.**

(15) See Art. **246.**

(16) (*a*) See Art. **231.**

(*b*) According to Art. **231,** fall 1 in 40 = 3 ft. in 120 ft.; 3 ft. + 1 ft. 6 in. = 4 ft. 6 in. depth of manhole. Ans.

(17) See Art. **240.**

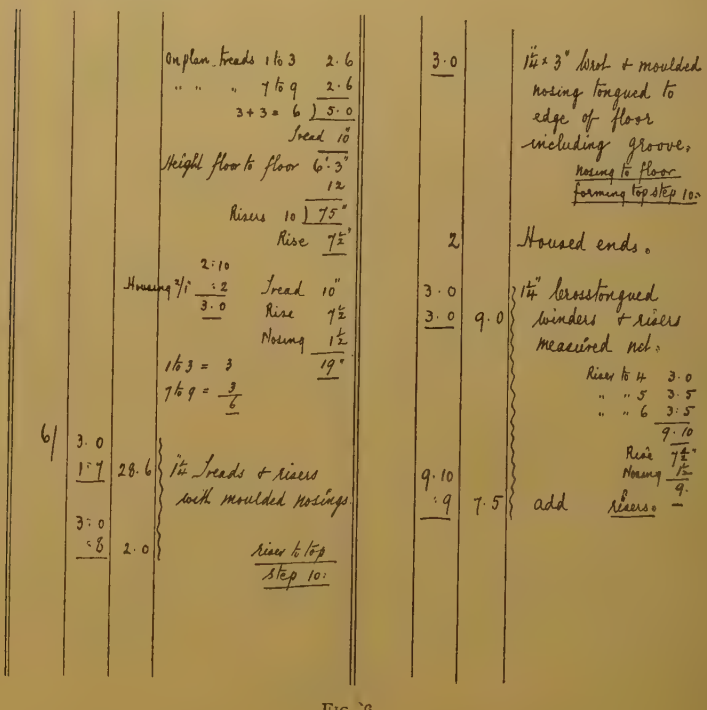

FIG. 6

(18) (*a*), (*b*), and (*c*) See Art. **148.**

(19) See Art. **177.**

(20) (*a*) See Art. **153.**

(*b*) According to Art. **153,** 2 extra-large five-light frames with transom, 10 large sheets, and 10 extra large sheets. Ans.

Bricklayer.

Brickwork in mortar.

1 Brick			1½ Brick			Cube		Extra only in Cement.		
170·0		Ddt	4·6		Ddt	82·6		1 Bk	1½ Bk	
42·0		42·0	12·0		21·0	9·2·⅓				
128·0			1,809·0			73·4		25 6	36·0	
42	8·⅓		904·6					8·6·⅓	17·0	
85	4		804·0					17·0	53 0	Reduc
			3,534·0							
			21·0							
			3,513·0							
			85·4							
			73 4							
			3,671·8							
			Rods. feet							
			13·136							

Ro
Cu
11

		Run					
...tra to ...air ...ternal ...ce to ...ickwork.		Extra to fair bullnose angle.		Rake, wedge, & point flashings.			Ends of timbers cut and pinned.
				10·6	D° stepped.		
...5·0 ...d·S 22		15·0			38·0		12
			Levelling & preparing old 2 brick wall for raising.				
			10·0				
...ck ...rtition ...thick.							
...8·0 ...d. S. 12							

Plumber.

Milled lead in flats, flashings, gutters, stepped flashings.						h. welted edge to 5 lb. lead.
6 lb.	5 lb.	4 lb.				13.6
63.9	18.0	30.0				
53.3	lb.	lb.				
117.0	90	120				
lb.						
702						
90						
120						
912						
C. gr. lb						
8.0.16						
						h. welted joint to 6 lb.
						31.0

se per ling.			Bossed ends to rolls.			Soldered dots and Copper screws & sinkings in deal for same.	
.0			10			6	
				Extra labour & solder to 3 spools.			
				3			

QUANTITIES AND ESTIMATING

(PART 3)

(1) See Art. 5.
(2) See Art. 3.
(3) See Art. 10.
(4) See Art. 27.

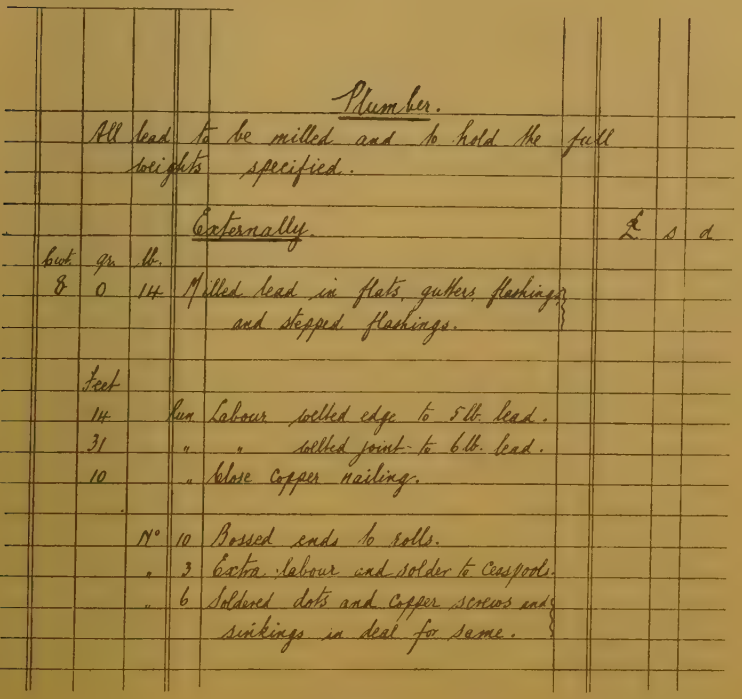
Plumber.
All lead to be milled and to hold the full weights specified.
Externally.
£ s d
Cwt qrs lb.
8 0 14 Milled lead in flats, gutters, flashings and stepped flashings.
Feet
14 Run Labour welted edge to 5lb. lead.
31 " " welted joint to 6lb. lead.
10 " Close copper nailing.
N° 10 Bossed ends to rolls.
" 3 Extra labour and solder to Cesspools.
" 6 Soldered dots and copper screws and sinkings in deal for same.

FIG. 3

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(5) See Art. **21.**

(6) See Arts. **28** to **32.**

(7) See Art. **12.**

(8) See Art. **35.**

(9) See Art. **33.**

	Feet				£	s	d
	5		Run	Turning piece to 4½" segmental soffit			
	10		Cube	Fir in wall plates.			
	13		"	Fir in ground joists and sleepers.			
	28		"	Fir framed in floors.			
	64		"	Ditto in roofs.			
Squares				Deal			
12	80		Sup	1¾" × ¾" Sawn battens for plain tiling to 4" gauge.			
12	80		"	¾" Roof boarding edges shot.			
	220		Run	Labour splayed edge on ¾" boarding.			
	162		"	" ditto across grain.			
	20		"	1½" × 2" Herringbone strutting to 9" joists (joists not deducted)			
	125		"	Eaves tilting fillet out of 5" × 2"			
Yards							
142	~		Sup	Inodorous roofing felt well lapped and nailed (measured net – no allowance made for laps.)			

FIG. 4

(10) See Art. **40.**

(11) See Arts. **3, 13** to **16, 41,** and **58** to **61**; also Figs. 1 and 2.

(12) See Art. **9.**

(13) See Art. **71.**

(14) See Arts. **62** and **66** to **70**; also Fig. 3.

(15) See Art. **61.**

(16) See Arts. **62** and **67** to **70**; also Fig. 4.

(17) See Art. **75.**

(18) See Art. **82.**

(19) See Art. **79.**

(20) (*a*) See Art. **88.**
(*b*) See Art. **87.**

QUANTITIES AND ESTIMATING

(PART 4)

(1) See Art. **10.**

(2) See Art. **8.**

(3) See Art. **4.**

(4) See Art. **2.**

(5) See Arts. **4** and **7.** [125 ft. 3 in. + (18 in. × 2)] × [52 ft. 5 in. + ($22\frac{1}{2}$ in. × 2)] × [23 ft. 6 in. + (12 ft. × $\frac{3}{4}$)] = 234,110 ft. cube, nearly. 234,110 ft. at 1d. = £975 9s. 2d. and at 11d. = £10,730 0s. 10d. This, plus £150 + £250 = £11,130 0s. 10d. Ans.

(6) (*a*) See Art. **19.**
(*b*) See Art. **21.**

(7) See Art. **10.**

(8) See Art. **39.**

(9) See Art. **36.**

(10) See Arts. **41** to **43.**

(11) See Arts. **34** and **35.**

(12) See Art. **59.**

(13) See Art. **72.**

(14) (*a*) and (*b*) See Art. **78.**

(15) See Table X.

(16) See Art. **91.**

(17) See Art. **80.**

(18) See Art. **88.**

(19) See Arts. **127** and **129.**

(20) See Art. **95.**

LONDON BUILDING LAW

(PART 1)

NOTE.—In addition to reference being made to the articles here mentioned, the London Building Act, 1894, should be consulted. By referring to the articles specified with regard to each question, the particular sections of the Act which are required to be consulted may be ascertained.

(1) See Arts. **5** and **6.**

(2) See Arts. **10** and **11.**

(3) See Art. **17.**

(4) See Art. **12.**

(5) See Arts. **31** and **32.**

(6) See Art. **90.**

(7) (*a*) and (*b*) See Art. **38.**

(8) See Art. **20.**

(9) See Art. **13.**

(10) (*a*) and (*b*) See Art. **74** and Fig. **6.**

(11) See Art. **76.**

(12) (*a*) See Art. **102.**
(*b*) See Art. **103.**

(13) See Arts. **79** and **80.**

(14) See Art. **65.**

(15) See Art. **71.**

(16) See Art. **46** and Fig. **3.**

(17) See Art. **97.**

(18) See Arts. **86** and **87.**

(19) See Art. **36.**

(20) (*a*) and (*b*) See Art. **104.**

LONDON BUILDING LAW

(PART 2)

(1) See Art. **69.**
(2) See Art. **6.**
(3) See Art. **24.**
(4) See Art. **33.**
(5) See Art. **29.**
(6) See Art. **48.**
(7) See Art. **53.**
(8) See Arts. **81** and **84.**
(9) See Arts. **104** and **105.**
(10) See Arts. **90** and **92.**
(11) See Arts. **25** to **27**
(12) See Art. **43.**
(13) See Art. **111.**
(14) See Art. **108.**
(15) See Art. **113.**
(16) See Arts. **100** to **103.**
(17) See Art. **83.**
(18) See Art. **67.**
(19) See Art. **9.**
(20) See Art. **19.**

PROVINCIAL BUILDING LAW

(1) See Art. **3.**

(2) (*a*) See Arts. **8** and **9.**
(*b*) See Arts. **4** and **7.**

(3) See Art. **1.**

(4) See Arts. **17** and **18.**

(5) See Arts. **30** and **31.**

(6) See Art. **33.**

(7) See Arts. **19** and **20.**

(8) See Art. **26.**

(9) See Arts. **10** and **11.**

(10) See Art. **79.**

(11) See Art. **20.**

(12) See Art. **107.**

(13) See Arts. **77** and **78.**

(14) See Art. **34.**

(15) (*a*) See Art. **91.**
(*b*) See Art. **109.**

(16) See Art. **100.**

(17) See Art. **86.**

(18) See Arts. **102** and **110.**

(19) See Art. **84.**

(20) See Art. **87.**

EASEMENTS

(1) See Art. **1.**
(2) See Arts. **12, 13,** and **16.**
(3) See Arts. **2, 9,** and **13.**
(4) See Art. **4.**
(5) See Art. **13.**
(6) See Art. **23.**
(7) See Arts. **18** and **22.**
(8) See Arts. **6** and **63.**
(9) See Art. **45.**
(10) See Art. **52.**
(11) See Arts. **75** and **76.**
(12) See Arts. **59** and **60.**
(13) See Art. **24.**
(14) See Arts. **73** and **76.**
(15) See Art. **47.**
(16) See Art. **24.**
(17) See Arts. **14** and **15.**
(18) (*a*) See Art. **29.**
(*b*) See Art. **37.**
(19) (*a*) and (*b*) See Art. **7.**
(20) See Art. **62.**

BUILDING CONTRACTS

(1) See Art. **1.**

(2) See Art. **3.**

(3) See Arts. **53** and **21.**

(4) See Art. **23.**

(5) See Arts. **8** and **10.**

(6) See Art. **30.**

(7) (*a*) See Arts. **18**, **33**, **37**, and **38.**
(*b*) See Arts. **18** and **33.**

(8) See Art. **34.**

(9) See Arts. **75** to **77.**

(10) (*a*) and (*b*) See Art. **16.**

BUILDING SUPERINTENDENCE

(PART 1)

(1) See Art. **2.**

(2) See Arts. **103, 104,** and **111.**

(3) See Art. **10.**

(4) (*a*) See Arts. **5** and **6.**
(*b*) See Arts. **7** and **8.**

(5) See Art. **42.**

(6)

Back-sight	Inter-mediate	Fore-sight	Rise	Fall	Height Above Datum	Mark	Distance Total	Remarks
4·57					91·39	B.M.		Starting point
		3·72	·85		92·24	Sta. 1	100	Changing Sta.
5·42					92·24			
	4·50		·92		93·16	Sta. 2	200	
		3·17	1·33		94·49	Sta. 3	300	Changing Sta.
4·91					94·49			
	4·90		·01		94·50		340	
		6·38		1·48	93·02	Sta. 4	400	Changing Sta.
3·38					93·02			
	4·60			1·22	91·80	Sta. 5	500	
		5·40		·80	91·00	Sta. 6	600	Changing Sta.
2·76					91·00			
	3·10			·34	90·66		670	
	3·80			·70	89·96	Sta. 7	700	
		6·92		3·12	86·84	Sta. 8	800	Closing Sta.
21·04		25·59	3·11	7·66				
		21·04		3·11				
		4·55		4·55	Proof of correctness			

(7) (*a*) and (*b*) See Art. **44.**

(8) See Arts. **79** to **88.**

(9) (*a*), (*b*), (*c*), and (*d*) See Arts. **103** and **106.**

BUILDING SUPERINTENDENCE

(PART 3)

(1) See Art. **6.**
(2) See Arts. **24** and **25.**
(3) See Art. **10.**
(4) See Art. **35.**
(5) See Art. **11.**
(6) See Arts. **41** and **42.**
(7) See Art. **46.**
(8) See Arts. **77** to **79.**
(9) See Art. **70.**
(10) See Art. **61.**
(11) See Art. **68.**
(12) See Art. **90.**
(14) See Art. **14.**
(15) See Art. **16.**
(16) See Art. **25.**
(17) See Arts. **82** and **83.**
(18) See Art. **66.**
(19) See Art. **58.**
(20) See Arts. **95** to **99.**

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NOTE.—All items in this Index refer first to the section and then to the page of the section. Thus, *Abstracting, §72, p3,* means that *Abstracting* will be found on page 3 of section 72. When there are several items having the same key word, this is, for brevity, omitted after the first reference, and the other items are indented, or set in, from the left margin, to indicate this omission, which never consists of more than one word. Thus, under the key word *Abutments* is found the indented item, *in tiling, Square;* this is read *Square abutments in tiling*, the capitalization of *Square* denoting the first word of the reference.

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